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1939, No. 1 March 9

On North American Snakes of the Genus *Leptotyphlops*

By Edward H. Taylor

THE following notes are based on specimens in the Kansas University Museum collection (KU), and the E. H. Taylor-H. M. Smith Mexican collection (EHT–HMS).

Leptotyphlops humilis cahuilae Klauber

Plate I, Figs. 5 and 6

A specimen (KU 6665), which I collected at Gila Bend, Maricopa Co., Arizona, has the following characters: Dorsal scale count 293; total length, 137.5 mm.; tail, 8 mm.; width of body, 2.2 mm.; ratio of width to length, 60; tail length in body length, 17.1 times. Nasal completely divided; lower labials 5–4. A single labial between ocular and nasal. The specimen is very light and little or no pigmentation can be discerned.

Leptotyphlops albifrons (Wagler)

Plate I, Figs. 11 and 12

Three specimens in the EHT–HMS collection as follows: No. 5248, Paso de Ovejas, Veracruz, July 17, 1932, E. H. Taylor, collector; Nos. 5249, 5256, near San Ricardo, Chiapas, Sept. 2, 1935, H. M. Smith, collector. These have the following scale counts and measurements (in millimeters), respectively: Dorsal scales (rostral to tip of tail), 240, 244, 254; subcaudals, 19, 17, 15; total length, 121, 135.5, 100.5; tail, 8, 8, 5; body width, 2.5, 3, 2.2.

Ventrals a little smaller than dorsals; nasal completely divided. White spots on rostral; also one on lower part of ocular and last upper labial. The extreme tip of tail and an area on the underside of tail yellowish; scales of the seven (or nine) dorsal rows with lighter edges leaving a series of irregular dark lines on body; seven (or five) ventral rows with a nearly uniform pigment, much lighter than dorsal surface.

It is not absolutely certain that the name *albifrons* is correctly applied to this Mexican species. The type locality of *albifrons* is Brazil.

Leptotyphlops bakewelli Oliver

Plate I, Figs. 13 and 14

Leptotyphlops bakewelli Oliver, Occ. Papers Mus. Zool., Univ. Mich., No. 360, 1937: 16 (type locality, Paso del Rio, Colima).

A paratype (EHT–HMS No. 5477, Paso del Rio, Colima; Smith, July 8, 1935) has dorsal scale count 256; 22 scales under tail; total length, 120 mm.; tail, 8.5 mm.; body width, 2.4 mm. Chin, throat, and anterior ventral part of body white; seven dorsal rows of scales edged with light, leaving alternate rows of dark brown and light on the back. The absence of the prefrontal scale (by fusion with the rostral) characterizes this form.

Leptotyphlops myopica (Garman)

Plate I, Figs. 9 and 10

Stenostoma myopica Garman, Mem. Mus. Comp. Zool., 8, No. 3, 1883: 6, 131 (type locality "near Tampico," Tamaulipas, Mexico).

Leptotyphlops myopica Stejneger and Barbour, Check List N. Amer. Amph. Rept., 3rd Ed., 1933: 85.

Glauconia dissecta Cope, Amer. Nat., 1896: 753 (type locality, Lake Valley, New Mexico) Ann. Rept. U. S. Nat. Mus., 1898, 1900: 716, fig. 142.

Leptotyphlops dulcis Burt, Amer. Mid. Nat. 16, 1935: 327 (Barber County, Kansas); Hibbard, Copeia, 1937: 74 (Meade and Clark counties, Kansas); Ortenburger, Biol. Sur. Oklahoma, 2, 1930: 182 (Kiowa and Cleveland counties, Okla.).

Stejneger and Barbour have recently placed *Leptotyphlops dissecta* Cope in the synonymy of *Leptotyphlops myopica* Garman and included the latter species in the fauna of the United States.

There are two specimens of *Leptotyphlops myopica* in the Kansas University Museum, KU 20206, Clark County, Kansas, Hibbard collector, and KU 20207, Meade County, Kansas, Kline collector. A third specimen collected by Little (No. 239) near Las Cruces, New Mexico, likewise is typical of *L. myopica;* a fourth is in the EHT-HMS collection, No. 5250A, four miles west of Saltillo, Coahuila, Mexico.

These specimens agree in having two labials preceding the ocular, the anterior low, the posterior higher, reaching level of the middle of the eye; nasal completely divided, edge bordering lip scarcely wider than labial border of first labial; nasal at its widest part, distinctly wider than widest part of ocular; supraoculars somewhat diagonally elongate, smaller than the prefrontal, which borders rostral; nasals not in contact behind rostral; width of ocular at labial border scarcely wider than that of second labial; third labial large; rostral fails to reach level of eyes; mental narrow; three large lower labials, third largest and completely concealed, bordered by three scales which appear to border mouth when it is closed and are usually (incorrectly) counted as labials. Ocular followed by a large anterior parietal which rests upon third labial, excluding temporal scales from ocular; posterior parietal scale large (broken on left side in 20206, also broken in type of *dissecta;* not in type of *myopica fide* Loveridge), normally separated from last labial by a single temporal scale. Scales in 14 rows, lateral rows somewhat larger than dorsal or ventral rows.

Measurements (in millimeters) and scale counts of EHT–HMS 5250A, KU 20206, and 20207, respectively: Total length, 208, 173, 138; tails, 10.5, 8.5, 7; body width, 4.9, 3.8, 3.5; tail length in body length, 19.8, 20, 19.7 times; body width in body length, 42.4, 45, 39; scales on dorsal part of body, rostral to tail tip, 236, 233, 240; subcaudals, 14, 13, 13.

Seven dorsal scale rows (five anteriorly) show a light fawn or brownish fawn coloration, the pigment on outer row distinctly lighter than on other rows; ventral coloration white without pigment; a light area covers lips and tip of snout to nasal suture; dorsal scales minutely edged with lighter.

In the specimen from near Las Cruces, New Mexico, dorsal scale count about 246; subcaudal scales 14; anterior parietal large; posterior parietal broken on both sides into two scales; eye (black part) closer to nasal than to supraocular.

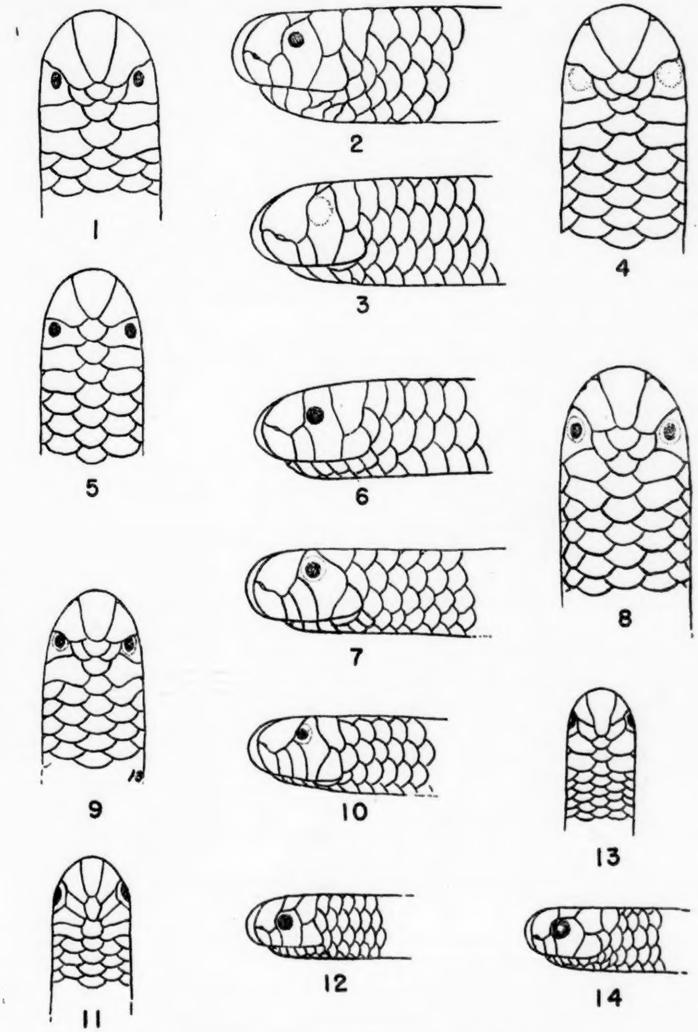

PLATE I. NORTH AMERICAN *Leptotyphlops*

Nos. 1–2, *Leptotyphlops dulcis*, KU No. 8485, Benton, Atascosa County, Texas, dorsal and lateral views (x 5). Nos. 3–4, *Leptotyphlops maximus*, MCZ No. 33667 (paratype), Chilpancingo, Guerrero, Mexico, lateral and dorsal views (x 4). Nos. 5–6, *Leptotyphlops humilis cahuilae*, KU 6665, Gila Bend, Maricopa Co., Arizona, dorsal and lateral views (x 7). Nos. 7–8, *Leptotyphlops bressoni*, EHT–HMS No. 5247 (type), El Sabino Uruapan, Michoacan, lateral and dorsal views (x 5). Nos. 9–10, *Leptotyphlops myopica*, KU 20206, Clark County, Kansas, dorsal and lateral views (x 5). Nos. 11–12, *Leptotyphlops albifrons*, EHT–HMS 5249, near San Ricardo, Chiapas, Mexico, dorsal and lateral views (x 5). Nos. 13–14, *Leptotyphlops bakewelli*, EHT–HMS No. 5477 (paratype), Paso del Rio, Colima, Mexico, dorsal and lateral views (x 5).

Messrs. Loveridge and Shreve have courteously compared the type of *Leptotyphlops myopica* with my drawing of a Kansas specimen, and find it in close agreement.

Leptotyphlops dulcis (Baird and Girard)

Plate I, Figs. 1 and 2

Rena dulcis Baird and Girard, Cat. North American Serp., 1853: 142 (type locality, between San Pedro and Comanche Springs, Texas).

Stenostoma rubellum Garman, Mem. Mus. Comp. Zool., 8, 1883: 130 (type locality, Uvalde, Texas).

Stejneger (1891: 502) has shown that *Stenostoma rubellum* was established by Garman under the misapprehension that *L. dulcis* had 15 scale rows and the upper nasals in contact, as erroneously stated in the original description.

A series of *Leptotyphlops dulcis* (EHT A397–405) was collected by Hobart M. Smith and myself near Brownsville, Texas, Sept. 8, 1932, during an overflow of the river. The specimens were found in a cornfield on floating debris. The water was from three to four feet deep. I collected three other specimens: one near Benton, Atascosa County, Texas (KU 8485), one near Eddy, Texas (EHT No. 404), one 3 miles east of Rio Grande City, Texas, (EHT 405). Another specimen, KU 1783, was collected by J. K. Strecker in Burnett County, Texas.

These specimens yield the following scale counts and measurements (in millimeters):

Scale Counts and Measurements of *Leptotyphlops dulcis* (Baird and Girard)

Number	8485	A405	A397	A400	A398	A402	A403	A401	A399	A404
Collection	KU	EHT	EHT	EHT	EHT	EHT	EHT	EHT	EHT	EHT
Total length	226	200	196	196	194	192	181	166	158	91
Tail	13	9	9	10	9.5	10	10	9	9	6
Body width	5	4	3.8	4	3.8	3.6	3	2.8	3.1	2.3
Tail in body length	17.4	22.4	21.8	19.6	20	19.2	18.1	18	17.8	15
Body width in total length	45.2	50	51	49	52	54	60	59	52	40
Scales from rostral to tip of tail	238	252	240	240	238	241	242	237	231	223
Scales under tail	14	14	14	14	15	15	16	14	14	15

Leptotyphlops maximus Loveridge

Plate I, Figs. 3 and 4

Leptotyphlops maximus Loveridge, Proc. Biol. Soc. Washington, 45, 1932: 151–152 (type locality, Chilpancingo, Guerrero).

Mr. Loveridge has kindly loaned me a paratype, MCZ 33607, from which the original description may be supplemented.

Scutellation.—Rostral somewhat narrowed at labial border, reaching its greatest width on most anterior part of snout near labial suture, from which point the scale narrows to its posterior end, which reaches back as far as middle of eye; rostral a fourth (or more) wider than nasal or ocular; nasal suture curving down where it reaches first labial, and curving up where it reaches the rostral; first labial about two and one-half times as high as wide, reaching level of nostril but not level of eye; width of ocular and lower nasal

on labial border somewhat greater than that of first labial; ocular relatively narrow, distinctly narrower than upper nasal, slightly angulate on its posterior border; second labial (last) a little higher than wide; a pair of parietals on each side, anterior broadly in contact with ocular, and resting on second labial; posterior parietal broadly in contact with the preceding, slightly wider, and separated from last labial by a single temporal scale; nasals not in contact behind rostral; prefrontal about same size and shape as the frontal; supraoculars longer than wide, their outer edge touching upper edge of eye spot; interparietal much wider than two preceding scales; three lower labials only (instead of five, as recorded for the type); 220 scales in a dorsal row from rostral to tip of tail; 15 subcaudals, the first, following anus, divided; anal plate triangular, slightly wider than long, single.

The head of this specimen has been injured, but the drawing is, I believe, correct for most details.

COLORATION.—Purplish brown above on dorsal rows and halves of adjoining rows; ventral rows dirty white; a light spot on snout and tip of tail; top of head less densely pigmented than dorsal half of body.

A small specimen in the EHT–HMS collection (No. 5246) from 12 miles south of Puente de Ixtla, Morelos, has been injured, but it agrees fairly well with the above paratype. Scales in a dorsal row 221; 16 scales under tail; total length, 126 mm.; tail, 7 mm.; diameter of body 2.5 mm.; tail in total length, 18 times; diameter of body in total length, 50 times. The five dorsal scale rows and half of each adjoining row light lavender-brown; other lateral and ventral rows whitish or creamy white; ventral part of snout cream.

This form is very similar to *Leptotyphlops dulcis*, but reaches a greater length and the proportions are also different. Thus in Texan specimens of *dulcis*, the tail length is contained in body length 17.4–22.4 times; in *maximus*, 18 to 25 times; the diameter of the body in total length, in Texan *dulcis*, 40–60 times; in *maximus*, 37 to 50 times. The color is more plumbeous or purplish in *maximus*, while Texan specimens of *dulcis* are lavender-brown or brown. There are also differences in the shape of the ocular and apparently also in the distinctness of the eye.

Leptotyphlops ***bressoni***, sp. nov.

Plate I, Figs. 7 and 8

TYPE.—EHT–HMS 5247, Hda. El Sabino, Uruapan, Michoacán, Mexico; Don Julio Raymond Bresson, collector.

DIAGNOSIS.—A large species (265 mm. in length) related to *Leptotyphlops myopica;* nasals divided; rostral reaching level of eye; greatest width of combined nasal not as great as width of ocular; supraocular present, separated from eye pupil by a distance equal to half its length; frontal small, lying between two large anterior parietals; posterior parietals equally large; anterior parietals separated from third (last) labial by a rather large postocular scale; two labial scales between ocular and nasal. Tail length in total length 19.6 times; body diameter in the total length 53 times.

DESCRIPTION OF TYPE.—Rostral distinctly wider than widest part of either nasal, extending back to level of eye; nasal completely divided, upper part extending somewhat beyond rostral, but not in contact with its fellow;

supraoculars present, widely separated from dark part of eye; frontal and prefrontal of about same size, interparietal much larger than either. Suture dividing nasal almost straight, somewhat diagonal; lower part of nasal much narrower than upper, its width on labial border equal to or a little less than that of adjoining labial; first labial short; second rising as high as lower part of nasal, and to level of eye; ocular irregular in outline, bulging out posteriorly and narrow at labial border; eye with very distinct black pupil in the center of a clear space; last labial about as long as high, separated from anterior parietal by a postocular scale, nearly as large as itself, separated by the same scale from the posterior parietal; parietals much widened, anterior somewhat the larger; mental small, narrow, grooved, but apparently undivided medially; four lower labials, posterior largest, and completely concealed by overhanging upper jaw.[1]

Scales in 14 rows about body; 10 about tail; 240 scales on dorsal line of the body; 16 subcaudals; between anus and first subcaudal is a diagonally placed pair of scales, in contact medially; tail distinctly flattened below; anal plate single, triangular, about one-fourth wider than long; median ventral scale row somewhat wider than adjoining rows; anterior head scales faintly tuberculate.

Measurements (in mm.).—Total length, 265; tail, 13.5; width of head, 4; width of body, 5; tail length in body length, 19.6 times; body diameter in length, 53 times.

Color in Life.—Purplish above on the seven dorsal rows (purplish brown in alcohol), dirty white below, with an indefinite lavender spot on each scale of the ventral rows, those on the median row most distinct; the outer row of the seven ventrals (third) has the whole scale lightly pigmented; head scales with a lighter border; lips and tip of snout cream but borders of scales edged with purplish.

Remarks.—The relationship of this species is apparently with *Leptotyphlops myopica* Garman which likewise has two labials between the ocular and nasal; it differs from this species in having a proportionately larger eyespot on ocular, a differently-shaped, much wider ocular, and a postocular scale separating the anterior parietal from the third labial. This latter character is not present in any other specimen of *Leptotyphlops* discussed here. The pigmentation of the ventral scales is a further difference from *myopica*.

Literature Cited

Baird, S. F. and Girard, C.
1853 Catalogue of North American reptiles in the Museum of the Smithsonian Institution, pt. 1, Serpents: XVI + 172.

Bocourt, M.
1882 Études sur les reptiles. *Mission scientifique au Mexique et dans l'Amérique Centrale, Recherches Zool.*, pt. 3, sect. 3, livr. 8: 499–507, pl. 29–30.

Boulenger, G. A.
1893 Catalogue of the snakes in the British Museum (Natural History), 1: 1–338, 28 pls.

Burt, Charles E.
1935 Further records of the ecology and distribution of amphibians and reptiles in the Middle West. *Amer. Midland Nat.*, 16: 311–366.

[1] In many descriptions the lower labials of these small snakes are incorrectly described, since, when the mouth is closed, the last lower labial cannot be seen and the two or three scales bordering the last labial are counted instead.

COPE, E. D.
1896 On a new *Glauconia* from New Mexico. *Amer. Nat.*, 30: 753.
1900 The crocodilians, lizards and snakes of North America. *Ann. Rep. U. S. Nation. Mus.*, 1898: 153–1294, 347 figs., 35 pls.

GARMAN, SAMUEL
1883 The reptiles and batrachians of North America, pt. 1, Ophidia. *Mem. Mus. Comp. Zool.*, 8, No. 3: XXXIV + 185, 9 plates.

GÜNTHER, ALBERT
1893 Reptilia and Batrachia. *Biologia Centrali-Americana, Rept.*: 81–88.

HIBBARD, CLAUDE W.
1937 *Hypsiglena ochrorhynchus* in Kansas and additional notes on *Leptotyphlops dulcis*. COPEIA, 1937: 74.

LOVERIDGE, ARTHUR
1932 A new worm snake of the genus *Leptotyphlops* from Guerrero, Mexico. *Proc. Biol. Soc. Wash.*, 45: 151–152.

STEJNEGER, LEONHARD
1891 Notes on some North American snakes. *Proc. U. S. Nation. Mus.*, 14: 151–152.

STEJNEGER, LEONARD and BARBOUR, THOMAS
1933 A check list of North American amphibians and reptiles, 3rd. ed.: XIV + 85.

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Two New Sphaerodactyls from Jamaica

By CHAPMAN GRANT

THE WRITER first visited and collected in Jamaica from March 20 to May 25, 1937. With the enthusiastic aid of André Henriques, eighteen very handsome sphaerodactyls were captured at Alligator Pond on the south coast. These agree with Barbour's plate of *S. richardsoni* Gray in his monograph on *Sphaerodactylus*. They also tally with his brief description, but do not agree with the color pattern given for this species by Gosse. The writer at the time noted in his MS of Reptiles of Jamaica: "Gosse gives a color pattern which we did not see."

During the writer's second visit to Jamaica and the Cayman Islands from March 9 to April 27, 1938, seventeen beautiful sphaerodactyls were collected from the vicinity of Montego Bay on the north coast. These were recognized as agreeing with Gosse's color description of *richardsoni* and not with Barbour's plate. Eleven more taken from the Port Maria–Roaring River area—which comprises about twenty miles of coast and lies about fifty miles east of Montego Bay—differed in color pattern from the Montego Bay specimens.

Gray unfortunately gave no type locality, so it was impossible to determine which of these very distinct forms was *richardsoni* without comparison with the type. Specimens were therefore sent to Mr. H. W. Parker at the British Museum. In a letter dated July 19, 1938, Mr. Parker states that

comparison with the type of *richardsoni*, which is a female, shows that it is undoubtedly the form represented by the examples sent him from Montego Bay. He had also another female taken by Gosse at Montego Bay. Hence it appears that Gosse's description was from a Montego Bay specimen, and that Montego Bay may therefore be designated the type locality.

Barbour collected three of the four specimens in the Museum of Comparative Zoology from "Kingston" in 1909, and H. L. Clark took one at Montego Bay in 1912. Barbour's plate is from a Kingston specimen. The series of four apparently was not sufficient for the difference from the northern species to be noted or possibly the Montego Bay specimen was mutilated, as is so often the case with these tender-skinned lizards. It is now clear that the Kingston specimens and my series from Alligator Point represent a new form.

The drawings are the work of Mr. Norman Bilderback, made available to me through the courtesy of Director C. G. Abbott of the San Diego Society of Natural History.

Sphaerodactylus **parkeri**,[1] sp. nov.

Sphaerodactylus richardsoni Barbour, Bull. Mus. Comp. Zool., 52, 1910: 290; Mem. Mus. Comp. Zool., 44, 1914: 268 (part); Mem. Mus. Comp. Zool., 47, 1921: 252 (part); Handbook of Jamaica, 1922: 667 (part); Zoologica, 11, 1930: 83 (part); *idem.*, 19, 1935: 102 (part); Bull. Mus. Comp. Zool., 82, 1937: 11 (part).

Type.—Grant collection 964, adult female, Alligator Pond, Jamaica, May 7, 1937, collected by Chapman Grant.

Diagnosis.—Close to *richardsoni*, from which it differs in having a wider, shorter, and deeper snout; in smaller size; in larger eyes; and in having an entirely different color pattern.

Description of Type.—Proportions as in sphaerodactyls in general except for the heavy head which resembles *roosevelti;* head deep; eye larger than in *richardsoni;* profile of snout short, steep, slightly concave; top of head visible in profile above eye; rostral with median groove, smaller than mental; nostril between rostral, a large internasal, a large supranasal and a smaller postnasal which separates it from the first labial; four upper labials followed by two small scales; three lower labials followed by one or two small scales; first lower labial almost as large as mental, third small; internasals separated mesially by a small scale; a small eye spine directed posteriorly; pupil vertical; granules on snout and head hexagonal, tubercular, as high as wide, becoming suddenly large across head at level of eyes and larger still at neck where the very large, obtuse, bluntly keeled imbricating dorsals begin; five dorsals equal the distance from snout to center of eye; two postmentals or several large granules border mental and labials; chin covered with fine hexagonal or round, flat scales to throat, where large, smooth, rounded, imbricating ventrals begin; scales along top and sides of tail pointed and sharply keeled, in whorls of one scale each; underside with one uneven central row of large, flat, semicircular scales bordered by flat scales of varying width interspersed with pointed, keeled scales on the sides.

[1] Named in honor of H. W. Parker, Curator of Reptiles at the British Museum (Natural History). I am much indebted to Mr. Parker for aid in defining *S. richardsoni*.

DIMENSIONS.—Snout to vent 33 mm., tail 33, in the type. This is the average adult size.

VARIATION.—A regenerated tail has smooth, pointed scales above and on sides and a row of wide, short plates underneath. There is some minor variation in labials and the supraocular spine.

COLOR PATTERN.—Adult male in breeding colors: tail lemon-yellow; head yellow above, but without pattern (Fig. 1, A); chin lemon-color, throat and sides of head orange; these colors fade completely in alcohol; belly clear except for fine dots just anterior to escutcheon; stripes across back almost obliterated; an incomplete black collar with two black dots immediately anterior to it; when not in nuptial colors essentially a gray lizard. Adult female: labials with dark centers; several incomplete black stripes across head from snout to ears; thence eight more complete stripes across body to sacrum; ten more to tail tip; black stripes preceded by gray and followed by white stripes; presence or absence of minute black dots determines color of scales; legs and toes also striped in three shades; throat and belly with gray shading or faint stripes; two black and three white stripes extend backwards from eye; essentially a conspicuously gray- and black-ringed lizard. Young similar to female, but more distinctly marked (Fig. 1, B, C, and D).

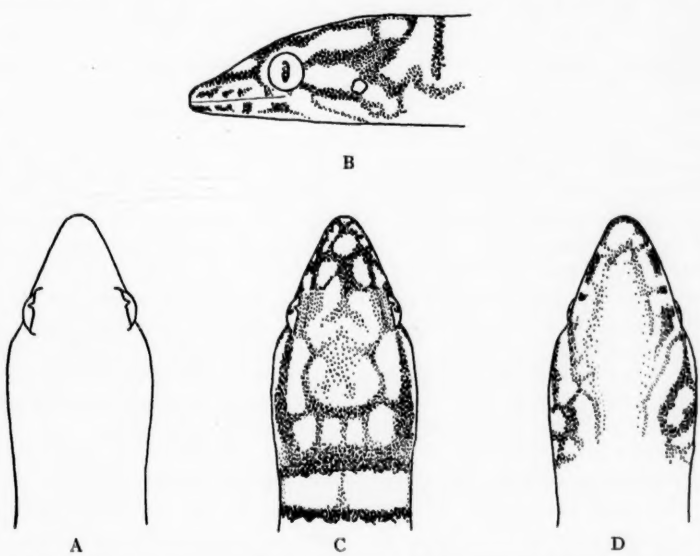


Fig. 1. Heads of *Sphaerodactylus parkeri*, x 3, to show form and color pattern (scales not shown). A, patternless head of male; B, C, D, female.

SEXUAL DIMORPHISM.—Male with escutcheon of flat, clear scales anterior to vent, about four scales long and extending nearly to knees; cloacal lips swollen as remarked by Noble for other species.

RELATIONSHIPS.—Allied to the coarse-scaled group which includes *roosevelti.* Further collecting around the western end of the island may prove this to be a subspecies of *richardsoni,* from which it differs in having coarser head tubercles, a shorter, wider snout, and in smaller size and entirely different color pattern.

HABITS.—It is found under heaps of cocoanut husks and trash in company with *S. argus henriquesi, Celestus crusculus* and a striped cricket. The similarity of this lizard to the cricket gives its vulgar name of cricket-lizard.

DISTRIBUTION.—Found near the shore from the vicinity of Alligator Pond on the south central coast eastward to the vicinity of Kingston.

Sphaerodactylus richardsoni ***gossei,*** subsp. nov.

TYPE.—Grant collection 2149, adult female, mouth of Roaring River, March 20, 1938, collected by Chapman Grant.

DIAGNOSIS.—A *Sphaerodactylus* of the *richardsoni* type in which the male has head markings similar to those of the female.

DESCRIPTION.—Proportions as in sphaerodactyls in general except for the snout, which is long, flat, and narrow resembling that of *oxyrrhinus;* head flat, eye smaller than in *parkeri;* rostral with median groove, smaller than mental; nostril between rostral, a large internasal, a supranasal, and a postnasal; the latter separates it from the first labial; four upper labials followed by one or two small scales; three lower labials followed by one or two small scales; three lower labials followed by several elongated scales; the first lower labial nearly as large as mental, the third very small; internasals separated mesially by a small scale; a moderate supraocular spine directed posteriorly; pupil vertical; granules on snout slightly elongated, keeled; granules between eyes elongated and keeled, hexagonal and tubercular on top of head; at level of ears, a collar of large tubercular scales followed on dorsum by large blunt and heavily but bluntly keeled imbricating scales, five in distance from snout to center of eye; profile of snout long, low, not concave, top of head barely visible above eye in profile; hind aspect of thighs finely granular, the large leg scales stopping abruptly; ventral aspect of humeral region and entire posterior aspect of foreleg finely granular; tail covered above and on sides by pointed, sharply keeled scales, below with an irregular row of larger flat scales; mental and lower labials bordered by larger, flat, hexagonal or round scales; throat covered by similar, fine scales progressively larger at neck and changing into large flat, rounded, imbricating scales on the belly.

VARIATION.—A regenerated tail has smooth scales and wide, short plates in a single row underneath. There is some variation in the labials.

DIMENSIONS.—Average adult 40 mm., snout to vent; tail approximately the same.

COLOR PATTERN.—Adult females: head markings shown in Fig. 2, E, F and G; posterior to collar in the drawing there are five more such rings or belts of a reddish-brown each edged with black; the intervening zones or bands are of the same color, but correspond to the zones described as "brown" in *S. r. richardsoni;* dorsal markings become indistinct or disappear on the light reddish-brown belly; throat dark gray between the white lines; limbs and digits indistinctly ringed like the body, each digit bearing two or three rings;

tail similar, but more distinctly ringed near the base; distally the rings are alternately jet black and porcelain white, or the black rings may have a pale central band. Adult male has the head markings as shown in Fig. 2, H, I, and J; these markings are vivid greenish-sulphur; the body is solid reddish-brown without markings; the limbs are faintly ringed; the throat light gray between the light markings; the belly a light reddish-brown; tail alternately ringed with yellow and gray, the yellow more pronounced distally. The one young taken is marked like the female, but much more vividly. Strangely enough a reproduced tail bears rings and not longitudinal stripes as usual in geckos.

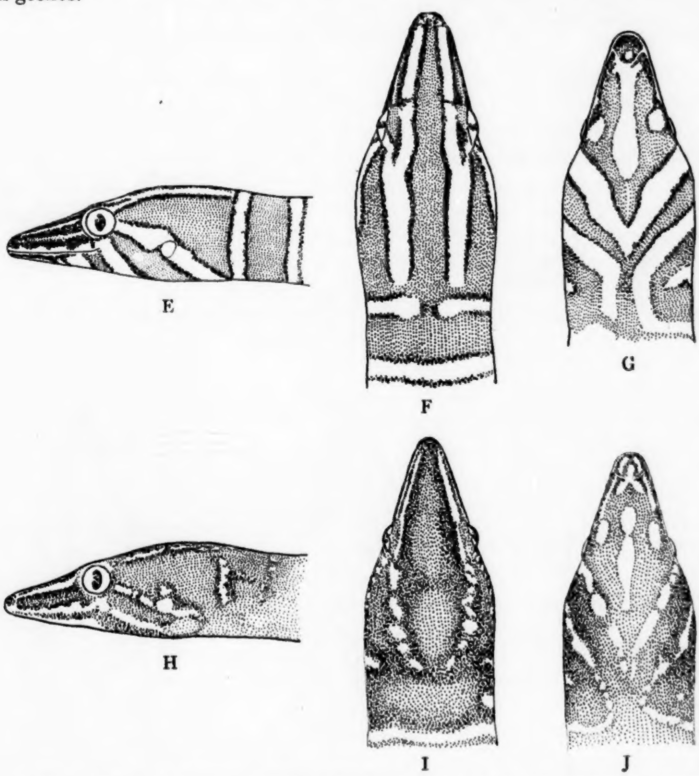


Fig. 2. Heads of *Sphaerodactylus richardsoni gossei*, x 3, to show differences between the sexes in color pattern. E, F, G, female; H, I, J, male.

Sexual Dimorphism.—The male has an escutcheon four scales long extending onto thighs as far as the knees.

Relationships.—Closest to *S. r. richardsoni* from which it differs greatly in color pattern; close to *S. parkeri* of the southern coast from which it differs in its smaller eye, and its narrower, flatter, and longer snout; derived

from the large-scaled group to which the heavy-headed *roosevelti* belongs.

DISTRIBUTION.—Near the coast from Port Maria to west of Roaring River, about twenty miles.

HABITS.—Found under piles of cocoanut husks where it lives in company with *Eleutherodactylus jamaicensis*. It is slower and more easily captured than the smaller members of the genus. It is known under the native name of "pawli."

Sphaerodactylus richardsoni richardsoni Gray

Sphaerodactylus richardsoni, Gray, Cat. Liz. Brit. Mus., 1845: 168; Cope, Proc. Acad. Nat. Sci. Phila., 1861: 497, 499; Reinhardt and Luetken, Vid. Medd., 1862: 174; Boulenger, Cat. Liz. Brit. Mus., 1, 1885: 227.

Sphaerodactylus richardsoni, Gosse, Naturalist's Sojourn in Jamaica, 1851: 254–256.

TYPES.—Brit. Mus. 1845 . 2 . 20 . 5, female, collected by Sir John Richardson, and 1847 . 12 . 27 . 53, female, Montego Bay, collected by P. H. Gosse.

DESCRIPTION.—Identical with *S. r. gossei* in squamation, dimensions, sexual dimorphism and habits.

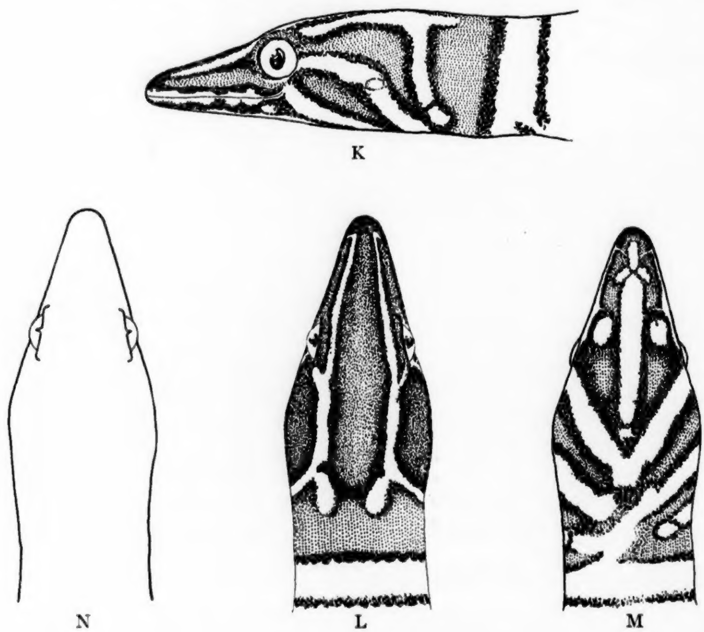


Fig. 3. Heads of *Sphaerodactylus richardsoni richardsoni*, x 3, to show color pattern. N, patternlesss head of male; K, L, M, female.

COLOR PATTERN.—Adult female: head markings as shown in Fig. 3, K, L, and M; the throat widely striped with black and the intervening narrow

spaces reddish-brown; the body rings of the same reddish-brown, edged conspicuously with black, the intervening bands being brown; the bands extend onto the belly, where the scales are heavily black-edged; limbs and digits conspicuously ringed in three colors; as the reddish-brown rings extend onto the tail they become lighter with an indistinct dark ring at their center; the light rings become progressively lighter until they become porcelain-white and the intervening spaces jet-black; the rings are not uniform. Adult male: head without pattern, Fig. 3, N; dark gray above, somewhat darker on the head and a very few widely scattered dark brown scales on the back; lighter gray underneath, somewhat darker on throat; escutcheon clear; tail alternately and evenly ringed with light and dark gray with a yellowish cast. Four half-grown females were more brilliantly marked. The young is unknown.

Distribution.—Apparently confined to the vicinity of the coast in the neighborhood of Montego Bay.

Discussion.—This species may intergrade with *S. r. gossei* in the area between Roaring River and Montego Bay, a distance of about fifty-five miles, but the writer collected rather intensively about twenty miles east of Port Maria, the only area where *S. oxyrrhinus* was found, without taking any of the *richardsoni* group. Knowing the extremely spotty occurrence of this genus it is also possible that no intergradation takes place.

Key for Determination of Jamaican Sphaerodactyls

A. Belly scales keeled .... *goniorhynchus*
AA. Belly scales smooth
  B. 14–16 mid-dorsal scales equal distance from snout to center of eye
    C. Snout slender, flat; two ocelli at sacrum .... *oxyrrhinus*
    CC. Snout normal
      D. Dorsum with white ocelli or plain .... *argus argus*
      DD. Dorsum with stripes largely replacing ocelli .... *argus* n. subsp.[2]
  BB. About 5 mid-dorsal scales equal distance from snout to center of eye
    C. Large tubercular neck scales extend nearly to eyes, snout blunt .... *parkeri*
    CC. Large tubercular neck scales extend nearly to ear openings, snout pointed
      D. Male with head markings; female with light belly .. *richardsoni gossei*
      DD. Male without head markings; female with dark belly .... *richardsoni richardsoni*

San Diego, California.

[2] Description in press in Jamaica.

Data on Size, Growth and Age in the Box Turtle, *Terrapene carolina*

By J. T. Nichols

SINCE 1915 I have been measuring, marking, and recording box turtles, *Terrapene carolina* (Linnaeus), at Mastic, Long Island, including a very few in other parts of the island, or brought to Mastic from other parts.

Recently Hope Ranslow Bennett has sorted and compiled for me the data so obtained from 1915 to 1937. The study of the data brings out certain facts about this interesting animal.

Size

I have measurements of plastron length to ⅛ inch of 843 individual turtles as follows:—

TABLE 1

PLASTRON MEASUREMENTS OF 843 INDIVIDUALS OF *Terrapene carolina*

Plastron length	No. Spec.	Plastron length	No. Spec.
1⅛–1½	10	4⅛–4½	48
1⅝–2	7	4⅝–5	155
2⅛–2½	8	5⅛–5½	418
2⅝–3	23	5⅝–6	103
3⅛–3½	29	6⅛–6¼	3
3⅝–4	39		

These figures show a very definite maximum size limit at about 6 inches; and a usual length for full grown turtles of 5⅛ to 5½ inches. Obviously the smallest sizes do not have proportional representation in those found and measured.

In Table 2 data are given on 90 turtles which, when recaptured and remeasured in succeeding years, showed no change in length of plastron for periods of one to 15 years.

TABLE 2

MEASUREMENTS OF *Terrapene carolina* WHICH FAILED TO SHOW INCREASE IN PLASTRON LENGTH

Plastron length	No. Spec.	Years between measurements	Plastron length	No. Spec.	Years between measurements
2⅞	1	1	5⅛	17	1 to 13
3⅝	1	1	5¼	25	1 to 10
4⅜	1	1	5⅜	8	1 to 14
4⅝	1	10	5½	15	1 to 15
4¾	3	1 to 3	5⅝	8	1 to 12
4⅞	3	3 to 5	5¾	4	2 to 8
5	4	1 to 8	5⅞	2	1 to 14

The turtles of 2⅞ and 3⅝ inches were nothing like full grown, but show a pause in growth for a year. At larger sizes growth may be intermittent, resumed after longer pauses. One turtle, with plastron 5½ inches for 4 years, had increased to 5¾ at the end of the next 8 years. Another with

plastron 4⅜ when first taken had increased to 4¾ a year later (a gain of ⅜ inch in one year), remained unchanged for the next 3 years, and 6 years later measured 5⅜ (a gain of almost ⅛ inch for each year).

Nevertheless the majority of these 90 turtles were no doubt essentially full grown. When last taken the turtle of 4⅝ inches had an estimated age greater than that of any other handled (60 years). There is presumably a main peak in the curve of numbers of full grown turtles at 5¼ inches and secondary peak at 5½ inches.

Grown male and female turtles differ in various readily appreciable characters, for instance in eye color and in shape of the shell. These differences are not absolute, however, but form an unbroken series with only the extremes perfectly diagnostic. Whereas a large proportion of the turtles examined and marked were obviously some males and some females, no record was made of their sex.

Some were noted as having the plastron flat, some flattish, some slightly concave, and some concave. Now that it becomes of interest to compare the sizes of the two sexes, it is safe to assume that those in the first group with plastron over 4½ inches long (flat) were females, and that those in the last group (concave) were males. Of turtles above this size (4½ in.) 149 were recorded in the first group and 238 in the last. This is not evidence of sex ratio, and probably means only that a larger proportion of females than males were in the intermediate groups, but the numbers are sufficiently large to give a fair statistical idea of size in each sex.

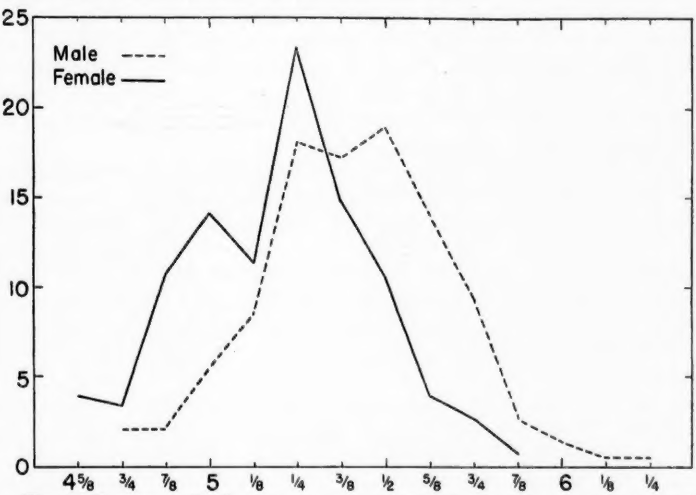


Fig. 1. Frequency distributions of male and female *Terrapene carolina* according to plastron length.

Results of measurements of male (concave) and female (flat) turtles are given graphically in Figure 1, where, in order to be comparable, frequencies have been reduced to percentages of total numbers of each sex. From these

frequency distributions it may be concluded that grown male turtles definitely average larger than female; that the largest number of females and a large number of males have a 5¼ inch plastron; that males reach a larger size than females and that most turtles over 5½ inches long are males and most grown turtles under 5⅛ inches females.

An unexpected and peculiar feature of these frequency curves is a shoulder at the beginning and a sharp shoulder just before the peak of each. That both curves show this peculiarity makes it unlikely that it is purely fortuitous, and I can think of nothing in the compilation or computation that might account for it. There may possibly be some heterozygous, physiological or environmental condition or factor with a tendency to produce smallish and very small turtles beyond those from the normal variation from the mean.

Growth from Rings

On Long Island at least, the box turtle does not molt the outer layer of the horny covering of its shell, which merely becomes smooth by wear as the individual grows old. In young turtles each horny scale shows clearly its original baby surface, surrounded by more or less concentric growth rings of varying width. The first few are broad, but then they become gradually narrower, less well defined, and difficult to count. At the same time wear begins to obliterate the demarcations between the earlier rings. There is frequently a ring narrower or broader than those adjacent and this can be traced on each and every scale. Occasionally after becoming narrow and ill-defined the rings become broader and better marked, which is attributable to a recurrence of growth after its practical cessation. On turtles up to a moderate size the number of rings is the same on each scale. The larger ones frequently have more rings on scales of the side of the carapace than on those of the plastron, showing further growth of the former part of the shell after it has ceased for the latter.

Partly due no doubt to the difficulty of marking small turtles satisfactorily, I have regrettably little return data on those found again in the period of most active growth. Such as there are corroborate the assumption that these rings are annual rings. Probably the first 5 or 6 broad ones are added pretty regularly, one each year, and later on years are missed with increasing frequency. The rings on turtles with up to 15 on the plastron scales can usually be counted fairly satisfactorily, and I would think an estimate of about 20 years for the average turtle to attain full size would not be far wrong.

I have no data to show just when the growth rings are added to the scales which cover a turtle's shell, or just how their addition is correlated with growth (or possibly shrinkage) of the shell.

In a few recorded cases the number added corresponds exactly with the years elapsed at recapture of the individual turtle:

Turtle JN-29-13, 4 rings added (5–9), 4 years elapsed;
JN-25-9, 10 rings added (5–15), 10 years elapsed;
JN-29-42, 7 rings added (8–15), 7 years elapsed;
JN-26-19, 3 rings added (10–13), 3 years elapsed;
JN-21-5, 1 ring added (13–14), 1 year elapsed.

In a larger number of cases the number of rings added is less than the years elapsed:

Turtle JN-27-17, 6 rings added (5–11), 7 years elapsed;
1 ring added (11–12), 2 years elapsed;
JN-27-20, 3 rings added (6–9), 4 years elapsed;
JN-24-54, 8 rings added (6–14), 12 years elapsed;
JN-23-13, 5 rings added (8–13), 8 years elapsed;
JN-28-4, 8 rings added (10–18), 9 years elapsed;
JN-33-39, 3 rings added (11–14), 4 years elapsed;
JN-21-5, 1 ring added (12–13), 2 years elapsed;
2 rings added (14–16), 7 years elapsed;
JN-26-19, 1 ring added (13–14), 8 years elapsed.

In three cases there was one more ring added than years elapsed.

Turtle JN-27-37, July 2, to (July 30) 6 years later, 7 rings added (5–12);
JN-27-39, July 2, to (Sept. 15) 7 years later, 8 rings added (6–14);
JN-23-13, June 21, to (July 1) 3 years later, 4 rings added (13–17).

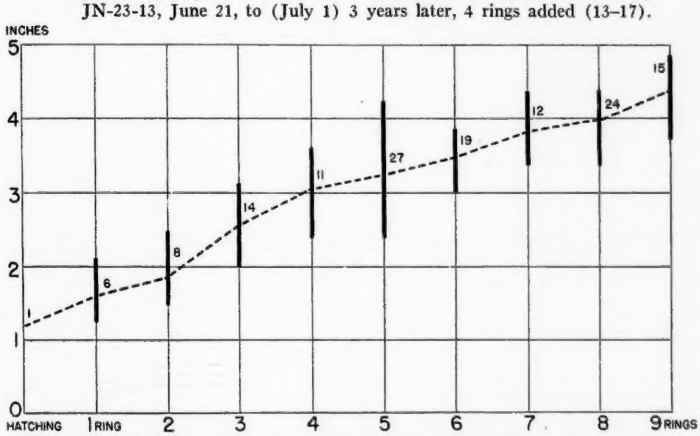


Fig. 2. Correlation between plastron length and number of rings in *Terrapene carolina*. Heavy lines on graph give the range of variation; numerals on graph represent numbers of individuals in each class; and the dotted line connects the means.

Correlation between plastron length and number of rings is shown graphically in Figure 2. The considerable spread of size in a given year group is notable. It presumably actually increases from year to year and is one factor which makes statistical data from the same number of individuals in the higher groups more liable to error. Another such factor is the increasing probability of interrupted growth, though this is a possibility even in the lower groups, for a turtle of 2⅞ inches with 4 rings on August 23 had the same length and number of rings on the June 27 following. A third such factor is the increasing possibility of overlooking a ring due to obliteration of the earlier or narrowing of the later ones. All in all the year group allocation of turtles with 6 to 9 rings is less reliable than that of those with 1 to 5 rings.

The smallest turtles recorded are so few in number that one must conclude they have not proportional representation in the total. Combining the number of individuals of 3 to 9 years as determined by rings, their propor-

tion to the total gives an average life expectancy of around 50 years. A considerable correction reducing this figure (perhaps to 40 years or less) should probably be made for those whose rings were not recorded, though up to 9 these are usually sufficiently noticeable and definite to be placed on record.

Growth from Measurements

There are 70 turtles the plastron measurement of which shows a net change of 1/8 inch and no more when they were recaptured in later years. As measurements were made only to the eighth of an inch under conditions which precluded invariable accuracy, there was doubtless this much deviation at times in remeasurement of the same plastron length. Hence this data is not used in growth studies except for statistical evidence which may be drawn from its analysis as follows.

From 3 7/8 inches one turtle increased 1/8 inch; from 4 1/2 inches one increased; from 4 3/4 inches 2 increased; from 4 7/8 inches 2 increased; from 5 inches 4 increased; from 5 1/8 inches 7 increased and 2 decreased the 1/8 inch. From 5 1/4 inches 7 increased and 7 decreased; from 5 3/8, 10 increased and 8 decreased; from 5 1/2, 5 increased and 5 decreased; from 5 5/8 2 increased and 4 decreased; from 5 3/4 one increased and one decreased; from 6 inches one increased.

It will be seen that in the size groups from 5 1/4 to 5 3/4 inches, 25 increased and 25 decreased. Deviation due to inaccuracy might be expected to be equal in the two directions, and if this is the case actual change is equal. Hence we have the statistical evidence of these 50 turtles that at these sizes slight decreases in length of plastron equal the slight increases which we know take place.

Seven other turtles contribute direct evidence of decrease in plastron length by measurements differing 1/4 inch, and it is quite likely that a slight shrinkage of the shell normally follows the completion of its growth. The measured length of one dropped from 5 1/8 to 4 7/8 inches in a period of 3 years. That of 2 dropped from 5 3/8 to 5 1/8 in one and 3 years, that of the last being the same a year later. That of 3 dropped from 5 1/2 to 5 1/4 in 4, 7 and 7 years, the first of these having previously risen 1/8 inch in a year, and one of the others found to be the same (5 1/4) a year later. That of the seventh remained at 5 5/8 for a year, dropped to 5 3/8 in 2 years, and remained there for a year.

There is a tendency for old turtles to seem too large for their shells, noted particularly in the very old individual elsewhere referred to (WF—84), which was measured as 4 5/8 over a period of 10 years. This may be brought about at least in part by shrinkage of the shell.

Only 42 turtles show appreciable growth (1/4 inch or more) when retaken in succeeding years. They start from plastron lengths ranging from 3 to 5 3/4 inches and reach 4 1/8 to 6 inches.

One of 3 inches grew to 4 5/8 in 7 years. Another of 4 5/8 grew to 5 1/8 in 3 years; another of 5 1/8 to 5 1/2 in 3 years; another of 5 1/2 to 5 5/8 in 2 years, then 5 3/4 in 3 years, and 5 7/8 in one year; another from 5 7/8 to 6 in one year. The growth rate between 3 and 4 5/8 inches is probably about 1/4 inch

a year, and above 4⅝ inches has ⅛ inch a year as usual maximum. The composite turtle which increased its plastron from 3 to 6 inches in 20 years, though not growing at maximum rate for the different sizes, may have made the distance as fast or faster than any given turtle would do it, for their growth is certainly sometimes and perhaps usually intermittent.

As examples of this, a turtle made unusually rapid growth from 4⅜ to 4¾ inches in one year, did not change for 3 years, and then grew to 5⅜ inches in 6 years; another remained at 5⅛ inches for 5 years, then grew to 5⅜ in 4 years; and another remained at 5½ inches for 4 years, then grew to 5¾ in 8 years.

Only 3 turtles had increased as much as 2 inches in plastron length when retaken in later years. One of 3¼ inches measured 5¼ 6 years later; another of 3¼ measured 5⅜ 10 years later; and a third of 3⅝ measured 5¾ 7 years later. The first and last of these are 2 of only 3 turtles showing an increase of over ¼ inch a year, the third being that which grew from 4⅜ to 4¾ inches in one year or ⅜ inch a year. A turtle which grew from 3⅝ to 4⅝ inches in 4 years has the longest record of ¼ inch annual increase.

My data on marked turtles do not lend themselves well to a study of the decreasing growth rate. The few small ones which have been retaken have usually increased too considerably, and there is no way of telling whether the larger ones have ceased growing several years before recapture. Furthermore the final size of each turtle, an important factor in the problem, is unknown.

However, averaging growth data between given sizes will give some idea of the rates. Figures which take a turtle ⅛ inch out of a group are nevertheless used for that group provided they leave ¼ inch growth or more in the group. Between 3 and 4½ inches (6 cases) the average growth thus obtained is 0.18 inches per year; between 4½ and 5 inches (6 cases) 0.08 per year; between 5 and 5½ (12 cases), 0.05 per year; between 5½ and 6 (7 cases), 0.04 per year. According to these figures the average turtle grows from 3 to 4½ inches in 8.3 years, 4½ to 5 in 5.9 years, 5 to 5½ in 10 years, 5½ to 6 in 14.3 years. The first two rates are probably about correct, the last two almost surely too slow, involving turtles that had ceased growing some time before recapture. A turtle that is going to reach 6 inches probably grows comparatively rapidly from 4½ to 5, making the growth from 3 to 6 in somewhere between 20 and 30 years.

Estimated Age

Certainly one of the oldest turtles handled, as evidenced by its smooth shell and other symptoms, was a small individual with plastron of only 4⅝ inches (WF—84, see Copeia, 46, 1917: 66), pretty surely a female though not obviously such in shape and color. This was marked (with no reasonable doubt as to authenticity) in 1884, 32 years before I first encountered it in 1916. From the relation of the mark to the shell it probably was about full grown or older when first marked, possibly, from what we have discovered of growth, no more than 10 but probably 20 or more years old. This turtle was found again in 1922, and in 1926, when I would consider 60 years a

conservative estimate of its age, and presumably died soon after. Twenty years would be my estimate of the average age for a turtle to attain full growth, though some large ones with 20 rings or more on the carapace, presumably take as much as 30 years. It does not seem unlikely that some of the oldest turtles encountered were between 60 and 80 years of age, but it must be very exceptional for one to exceed that figure. Males may develop a definitely concave plastron when this is 4¾ inches long and at about 12 or 14 years of age, which is presumably the lower limit for their sexual maturity. Where the lower limit for females lies there is no evidence, but some doubtless are full grown at 4⅝ inches.

AMERICAN MUSEUM, NEW YORK CITY.

Butler's Garter-Snake, *Thamnophis butleri*, in Ontario

By E. B. SHELLEY LOGIER

THAMNOPHIS butleri (Cope) may now be added to the list of snakes to be found in southern Ontario. It has been recorded from western New York and western Pennsylvania, Ohio, Indiana, southern Michigan and Wisconsin (Stejneger and Barbour, 1933), but we know of no previous record for Ontario.

The writer, in company with Mr. W. J. LeRay, of the Department of Biology, University of Toronto, spent a few days from July 5 to 8, 1938, in field work in the vicinity of Newbury in the southwest corner of Middlesex County, Ontario. The scene of most of our activity was at the thicket or "swamp" known locally as "Skunk's Misery," which has been set aside as a game preserve. The ground is flat and covered largely with second growth hardwood and brush, and with some clearings and pasture meadows. It is really more of a thicket than a swamp, for while it contains a few marshy areas of restricted extent and a few ponds most of the ground was dry at the time of our visit, but parts had evidently been wet early in the season. A road which runs southwest along the thicket is bordered by a grassy strip on each side and has a narrow, deep drainage ditch with a little shallow water for some distance along the northwest side. This ditch sustains a growth of cat-tails, sedges and other marsh vegetation, and ends at the intersection of a crossroad which cuts through the thicket. On the east corner at the crossroad is a small clearing grown to grass and weeds.

At twilight on our first evening, while searching the grassy margins of this road where the grass had been cut and raked into bundles, we noticed a small garter-snake disappearing under one of these bundles. We caught and examined it, and its identity as *Thamnophis butleri* was immediately apparent. We then turned the bundle and found a second one. Working with our flashlights we now turned bundles and searched the surrounding grass till long after dark but found no more that night. The next morning we showed these snakes to the farmer, Mr. Arthur Leech, who had cut the grass, and he kindly secured for us a third specimen when lifting the bundles later in the day. This one was taken at the corner near the small clearing. On the

following evenings, July 6 and 7, a total of twenty-seven more specimens was taken at this clearing and for a short distance along the same side of the road (the opposite side to the ditch). This section was also worked at different hours during the day, as were other types of habitat. It soon became apparent that Butler's garter-snake was active only in the evening from about sundown till dusk and was not to be found abroad at other times, at least during the hot weather at the time of our visit, with midday temperatures about 90° F. A single specimen was taken from some decaying timber in another clearing, perhaps half a mile or more distant, in the afternoon of July 7. This was also near to a drainage ditch, but without water.

The situation where these snakes were taken struck us as peculiar since it was dry and hot and exposed all day to the sun, and far removed from water of any extent, and thus not in accord with the previously noted habitat preferences of the species. Ruthven (1908: 89) records taking it in southern Michigan only in the immediate vicinity of water, and comments that "this may be a coincidence, but is in accord with all of the specimens collected throughout the range which have habitat data." Bishop (1927: 16, 17) records the taking of a specimen in the Tunungwant Valley near Limestone, N. Y., in a low, wet meadow bordering Tunungwant Creek. The grass in which we found our specimens was very fine and dry, and about a foot long where uncut in the corner clearing. Farther back in the clearing the grass was replaced by taller weeds, but the snakes were not found there. In their preferred habitat of longish grass they moved swiftly and with ease, but on the bare earth their movements were awkward and less efficient than those of *sirtalis.* They often worked low down in the shelter of the grass so that their presence was betrayed only by its slight movements and by a faint rustling. Some pieces of sheet metal lying on the ground yielded one or more specimens almost every time they were lifted at intervals of about fifteen minutes during the time when the snakes were foraging, but not at other hours of the day, so they evidently used these for temporary resting places, but not for denning up. There was a shallow excavation about eighteen inches deep in the clearing with some timbers embedded in the sides. Mr. LeRay succeeded in dislodging one of them and found several *butleri* behind it in company with *sirtalis,* and more in what seemed to be the burrow of some small mammal leading back from it. Some soil had been dug away on the roadside making a shallow depression which ended abruptly at the clearing fence. Here the sod overhung slightly where the earth had eroded away beneath and the process had evidently been helped along either by mice or by snakes, so that there were some cozy pockets underneath and several *butleri* were taken from these, again in company with *sirtalis.* Similar pockets, but less excavated, were found beneath the sod at the side of the cross-road, at the north corner, but yielded no snakes. Both situations where *butleri* was taken were near to drainage ditches, which, to judge by their vegetation, must be wet most of the year, although most of such ditches which we saw contained no free water. A few tadpoles were seen in the roadside ditch, but any frogs seen there or about the clearing where the snakes were taken were much too large to serve as food for *butleri.* The clearing

itself and the adjacent roadside appeared far too dry to yield earthworms at the surface of the ground, or small frogs. Under the circumstances one would have expected to have found the snakes frequenting the ditch for water or food, but this was not the case and a careful search of this and other ditches revealed no *butleri*, nor were they seen crossing the road between the clearing and the ditch. One snake of undetermined species was seen for an instant by Mr. LeRay in the dusk of our first evening before it disappeared down the side of the road ditch. Despite such scant evidence, we feel that some ecological value of these ditches may reasonably be assumed, and that they do probably supply some water and food to the snakes, and may even assist in their dispersal through areas which without them would be too difficult. The behavior of these snakes when picked up is different from that of *sirtalis*, most specimens clinging with perceptible pressure to the fingers with folds of their bodies or coils of their prehensile tails. Our collection of thirty-one specimens from Newbury district consists of twenty-three females, seven males, and one specimen too young to be sexed with certainty while alive. Most of the females appear to be carrying young.

The specimens collected are very uniform in coloration which is briefly as follows: Ground color above brown with two rows of alternating black spots along the dorsolateral band of each side; the lateral stripe, which centers on the third scale row and involves the edges of the second and fourth (until the fourth row is dropped behind the middle of the body), is straw yellow, this color continuing forward onto the upper labials; dorsal stripe paler and more whitish; sides below the lateral stripe rich chestnut to deep brown, darkest on the first scale row, the color extending well down onto the ventrals; a vertical light spot on the preocular. There is some variation in the tones of the yellows and browns and in the amount of yellow flecking on the edges of the dorsal scales, but the general uniformity and resemblance of color and pattern to that of a ribbon-snake impress one much more than the slight individual differences.

Ten specimens were preserved for scale study, the remainder are being kept alive for the present, most of them in Mr. LeRay's living collection at the Department of Biology. The dorsal scales are 19–19–17 in all specimens. One shows two extra very short rows of about a quarter inch in length immediately behind the head, giving a count there of 21. Davis (1932: 114) notes a similar condition in two Wisconsin specimens of *butleri*. The scutellation of the other parts shows some variation, except for the preoculars, which are 1–1 in all. The postoculars are 3–3 in five, 2–2 in three, 1–2 in one, and 1–1 in one; supralabials are 8–7 in one, 7–7 in three, 6–7 in one, and 6–6 in five; infralabials are 9–8 in two, 8–8 in five, 8–7 in two, and 7–7 in one. The temporals are 1+1 on both sides in the seven females, 1+2 on both sides in one male; the other two males show a second scale in contact with the first temporal on one side only. The ventrals range from 135 to 141 plus two half scales in the females, the average being 137; in the males they are 142, 144, 144. The dorsal scales on the neck region are glossy like the head plates and those immediately behind the head are unkeeled. The first scale row is either unkeeled or only very feebly keeled posteriorly, and the second

row is less strongly keeled than those above it. The largest female preserved measured 578 mm. in total length, and it is doubtful if any of our specimens would exceed this. The average total length of all specimens measured is 472.5 mm. The head length to the angle of the jaw averages 3.59 per cent of the total length with no appreciable difference between the sexes, its width averages 58.32 per cent of its length and 2.17 per cent of the total length from snout to tip of tail. The small head scarcely demarked from the narrow neck is a very conspicuous feature. The tail averages 21.12 per cent of the total length in the females and 23.38 per cent in the males. The subcaudals range from 52 to 61 in the females, averaging 55. In the males they are 60, 62, 62.

Literature Cited

Bishop, S. C.
1927 Butler's garter snake in New York. Copeia, 1927: 16–17.
Davis, D. D.
1932 Occurrence of *Thamnophis butleri* Cope in Wisconsin. Copeia, 1932: 113–118.
Ruthven, A. G.
1908 Variations and genetic relationships of the garter-snakes. *Bull. U. S. Nation. Mus.*, 61: I–XII + 1–201, figs. 1–82, pl. 1.

Royal Ontario Museum of Zoology, Toronto, Canada.

Notes on the Life History of the Tidepool Johnny (*Oligocottus maculosus*)

By C. E. Atkinson

IN FEBRUARY, 1937, an investigation was begun on the life history of the tidepool johnny (*Oligottus maculosus* Girard) after a trio of these fish had spawned in one of the author's aquariums. An examination of the literature yielded scant information about this fish, and although the species is of no great commercial importance, it seemed of scientific interest to start the accumulation of life history data about it.

The investigation was carried on at the laboratories of the School of Fisheries at the University of Washington, and the living specimens were obtained from Alki Point near Seattle and further studied there. The author wishes to express his appreciation to the Faculty of the School of Fisheries, who have in one way or another given assistance during the investigation, and to Miss Grace Shirk, librarian of the International Fisheries Commission, for her aid in checking the bibliography; but he especially desires to thank Dr. W. F. Thompson, Director of the School of Fisheries, for his many valuable suggestions.

In studying the problem, all specimens of *Oligocottus maculosus* in the collections at the University of Washington Fisheries Museum were examined, augmented by the aforesaid observations and collections from Alki Point. The measurements were taken as the distance from the tip of the snout to the base of the caudal fin. The weights of fish over 30 mm. in

length were taken on torque scales while the smaller specimens were weighed on an analytical balance. The results were recorded in grams. The ova used in the ova diameter frequencies of Figure 2 were measured by a filar micrometer eyepiece after being teased out of the ovarian tissue by means of a scalpel and needle.

Description and Range

The tidepool johnny is a small cottoid fish inhabiting rocky tidepools from Tunitas, California, to southern Alaska, and has been reported from the Okhotsk Sea (Schultz, 1936). It has been suggested by Greeley (1901: 16) that the southern limit of the fish may be determined by the decided change in the character of the tidepools. Below Pigeon Point, California, the coast is composed of great shelving ledges of hard sand-stone with very few pools. However, north of this point the rock formation changes and there appear along the coast numerous tidepools such as this species inhabits.

The usual coloration of these fish in the Puget Sound area is a soft gray, varying from an olive green to light brown. The ventral surface is cream, pale yellow, or even slightly lavender. The color of the head is uniform with that of the body but more or less vermiculated with white or olive. The throat is pale olive and the fins are grayish with darker bars or markings.

The males are easily distinguished from the females by the enlarged first two or three rays of the anal fin. The young males of Age-group 0 develop this modification after they have attained the approximate length of 30 mm. All males of Age-group 1 appear to have it, even those specimens examined (from Alaska area) that were but 23 mm. in length.

The sexes of the fish can also be determined by other means, though not so accurately. Nearly all the male cottoids have a characteristic, elongated penis. In the preserved specimens this organ is usually extended and easily seen, while on the living fish, it can be protruded by a slight pressure on the abdomen. In the tidepool johnny it is conical in shape, and for a male of 40 mm. in length, is approximately 1 mm. in diameter and 5-7 mm. long.

Early Life History and Spawning Habits

On February 13, 1937, three specimens of *Oligocottus maculosus*, one female and two males, were collected from the beach at Alki Point and placed in a two-gallon aquarium where the fish remained alive until March 11, when they were killed by a sudden rise in the temperature of the water.

A few hours after the fish were placed in the aquarium, the males began to pursue the female in quick jerks or hops aided by sudden movements of their pectoral fins. They appeared to keep their bodies well above the bottom of the tank by supporting themselves with rigid ventral fins and with the caudal peduncle. At times, a male would mount the female by placing one pectoral fin in the notch between her two dorsal fins. The posterior part of the body of the male curved upward slightly with the caudal fin expanded and rigid. The caudal fin of the female usually remained folded. On several occasions the body of the female was observed to become slightly rigid, her caudal fin expanded, and as the sexes came close together, a distinct pulsation was seen (approximately four per second). It was impossible to determine if this movement was originated by either or both fish. After several

seconds, the female would suddenly dart away and the male would either pursue her or fight the other male in the aquarium. Both males participated in this courting activity and on two occasions both mounted the female at the same time (one on each side).

On February 18, a single egg was observed attached to a rock at one end of the tank. Upon closer examination, however, a mass of eggs was discovered deposited between two rocks and filling the intervening cavity. The cluster was an irregular mass measuring 11.8 mm. by 8.2 mm., by 5.4 mm. thick. Though the eggs adhered rather loosely to their substrate, they were firmly attached to one another.

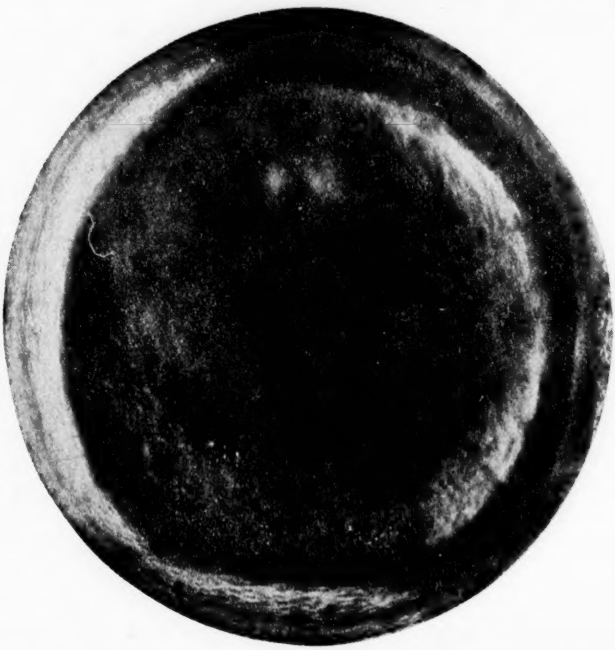


Fig. 1. A microphotograph of a three-day-old egg of *Oligocottus maculosus.*

The eggs are deep red in color and contain, when freshly deposited, numerous colorless oil globules which tend to unite as the eggs become more mature (Fig. 1). Those measured were 1.081 mm. to 1.549 mm. (average 1.221 mm.) in diameter and the perivitelline space averaged 0.05 mm. thick. Unfortunately they were attacked by fungus and died after about twenty days.

On March 9 a second female spawned a few eggs in another tank between a rock and the side of the aquarium. The eggs were not in a distinct cluster, only a small number being deposited, but they did agree in measurements with those previously spawned.

Among fish observed at Alki Point and those collected there on May 15, all females examined contained maturing ova. The latter collection contained females measuring 31-45 mm. in length and the majority of them may be classed as belonging to Age-group 1, or nearly one year old. Likewise, among the females of the preserved fish, all of which contained maturing ova (except a few small fish from Alaska collections), were specimens approaching their first year. On March 24, 1938, the author made a small collection at Lummi Island, in which were found three small maturing females of 24, 28, and 31 mm. in length. From these data it may be concluded that the tidepool johnny of the Puget Sound area probably matures in approximately one year.

It is believed that the spawning takes place during the months of April, May, June and July. Although the fish in the aquarium spawned on February 18, they may have been induced to do so by the close confinement, higher temperature of the water or other causes, and hence this spawning date is not taken here as necessarily indicative of the normal time.

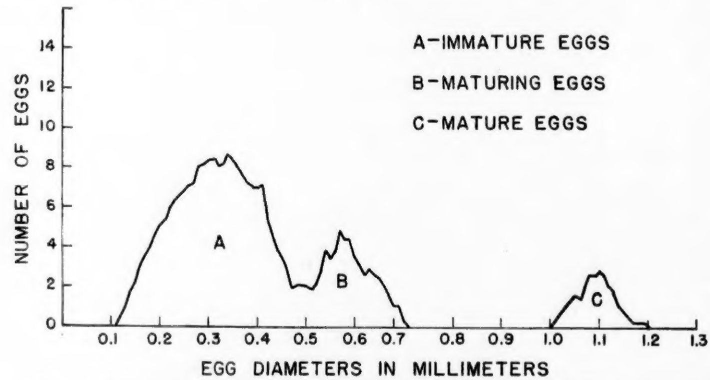


Fig. 2. Frequency curves of ova diameters from a mature female *Oligocottus maculosus.*

The young fish appear in the collections about the first of June and as the season progresses, there is a distinct spreading in the mode of the curve representing this group (Fig. 4). For example, in the collection of June 28, the range is 13-23 mm., while for August 20 it is 17-37 mm. Several explanations may be given for this increase in range.

(1) There may be a notable differential rate of growth in the young fish, some growing more rapidly than others. This undoubtedly is true to a limited extent; but since the difference is probably slight for that period when growth is usually greatest, it is doubtful if this explanation is sufficient.

(2) The young fish may appear in the collections through the summer months due to several successive spawnings of the mature fish. It has previously been shown by Thompson (1915), later by Clark (1934) and Hickling and Rutenberg (1936) that the diameter frequencies of the ova of a fish will serve as an index to the frequency of spawning. In the present

case, though the data are not sufficient to be quite conclusive, the diameter frequencies of the ova plotted in Figure 2 show three distinct modes, suggesting more than one spawning during a season. Also a number of females with maturing ova were found from March through July 28. Among the females in the collection of August 20, however, the ovaries were very small, and no maturing ova were present, an indication that the breeding season was over.

(3) Another logical explanation for the appearance of young fish throughout the summer season is the occurrence of races in this species of cottoids. At present, however, no information is available for recognizing races of this species.

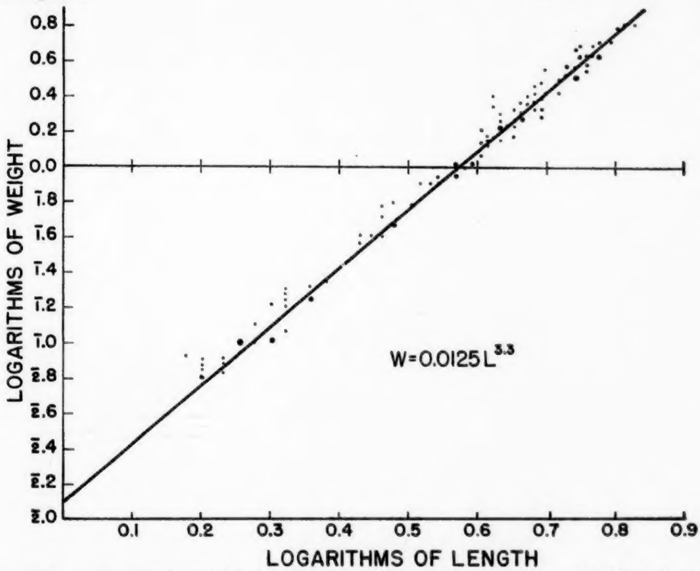


Fig. 3. The length-weight relationship of *Oligocottus maculosus*. (Number of specimens examined—278.)

Length-Weight Relationship

The length-weight data were plotted in a log-log graph, in which form the curve approaches a straight line (Fig. 3). The numerical values were divided into two groups and averaged, and a line was drawn connecting these two points, from which it was calculated that for the formula $W = FL^x$ (Clark, 1928), the value of F was 0.0125, and the value for x 3.3.

Age and Growth

To study the growth, a series of graphs was plotted showing the length frequencies of various collections examined. The data used are from two series of collections, one from the Puget Sound area (March 17, June 6, June 28, July 10, and August 8), the other from the Canadian-Alaskan area (January 6, 16, and 27, April 15, June 25 and 28, and July 30). Since collections

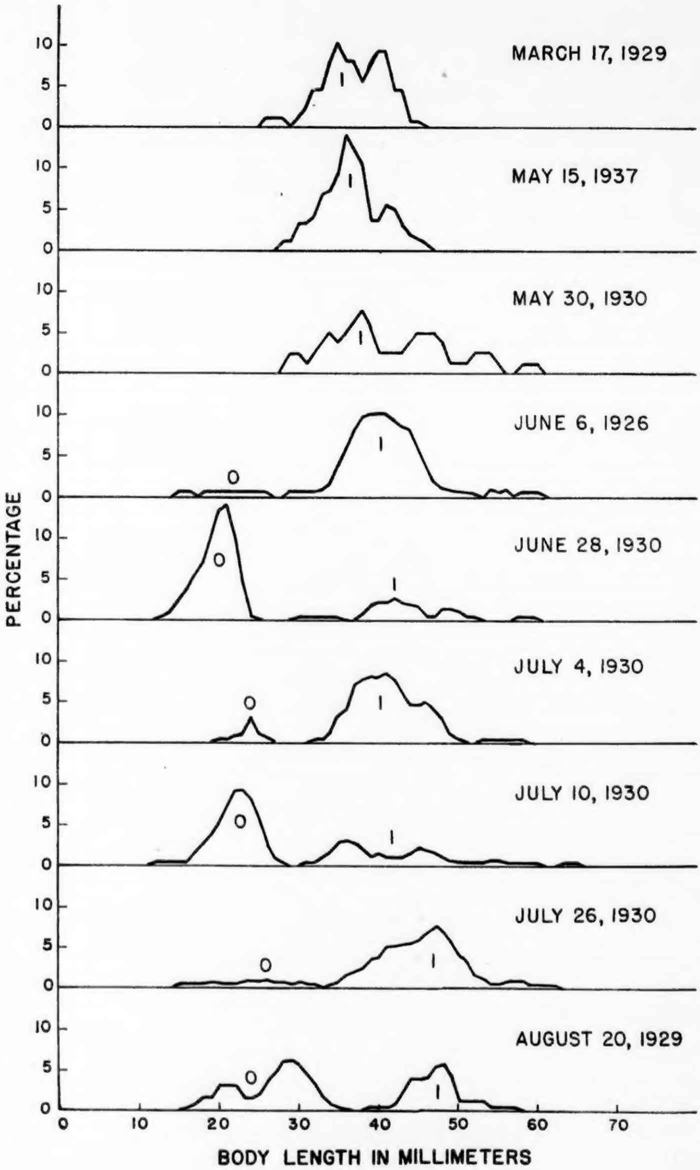


Fig. 4. Length frequency curves of collections from the Puget Sound Area.

were made at different localities and during different years, the results given probably only approximate the normal growth of the tidepool johnny. The length-frequencies taken were smoothed by a moving average of three to eliminate any minor fluctuations and the results plotted in Figures 4 and 5. Each of the age-groups represents all the fish of the same age in any single calendar year. For example, Age-group 0 includes fish of the year taken from June and July to December 31; Age-group 1 includes fish collected from January 1 to December 31 of the following year; and the subsequent age-groups cover like intervals of time. In Figure 5 a comparison is made between the collections from the Canadian-Alaskan area and those from the Puget Sound area, in which the difference in growth between the two areas is clearly shown.

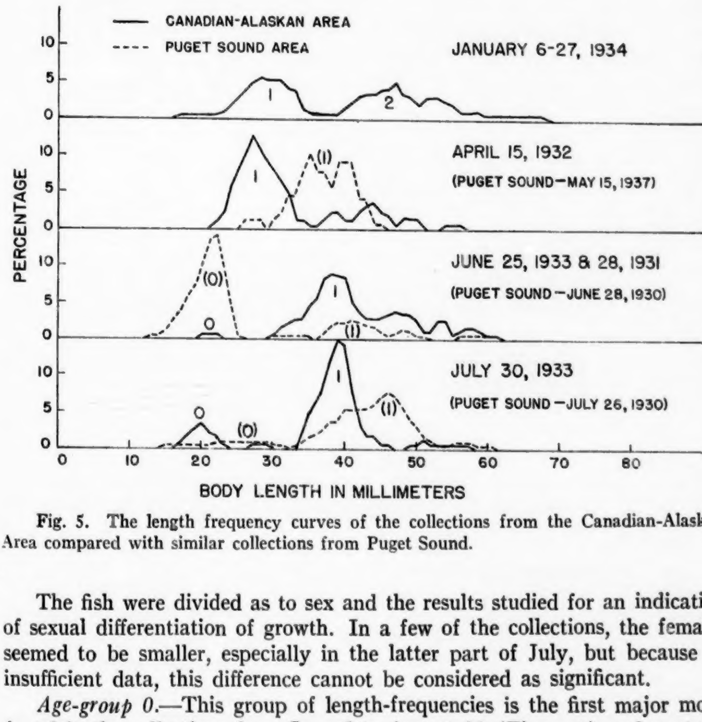


Fig. 5. The length frequency curves of the collections from the Canadian-Alaskan Area compared with similar collections from Puget Sound.

The fish were divided as to sex and the results studied for an indication of sexual differentiation of growth. In a few of the collections, the females seemed to be smaller, especially in the latter part of July, but because of insufficient data, this difference cannot be considered as significant.

Age-group 0.—This group of length-frequencies is the first major mode found in the collections from June 5 to August 20 (Figure 4) and contains fish from 15 mm. to 24 mm. (June 5) increasing to from 17 mm. to 38 mm. (August 20). Only eight fish were found from the Alaska area (Figure 5) which represent this group. They range from 21 mm. (June 28) to 19-22 mm. (July 30).

Subsequent Age-groups.—In the data from the Puget Sound area, illustrated in Figure 4, it was impossible to separate definitely Age-group 1 from the subsequent groups because of the overlapping of the modes due to the

decreased rate of growth of the older fish. It will be observed in this figure, however, that the composite mode progresses from 26+ mm. (March 17) to 42+ mm. (August 20).

In the collections from Alaska (Figure 5) the age-groups seem to be more isolated, due probably to a slower growth. Age-group 1 progresses from 20-35 mm. in January to 35-45 mm. in July. No later collections are available, but the mode must progress to about 40+ mm., judging from the size of Age-group 2 in January.

Summary

The present paper reports a study on the early life history, age and rate of growth of *Oligocottus maculosus* in Puget Sound and in the Gulf of Alaska. Specimens were collected and kept in an aquarium where a significant act, termed "Courting Act," was observed, but its relation to the actual spawning could not be determined. The eggs were deposited in a cluster 11.8 mm. x 8.2 mm. x 5.4 mm., were deep blood-red in color, and contained, when first spawned, numerous oil globules. The measurements were, (a) diameter, 1.081-1.549 mm. (average 1.221 mm.) and (b) perivitelline space, average .05 mm. The length-weight relationship is expressed by the formula $W = FL^x$, in which $F = 0.0125$ and $x = 3.3$. From a study of the diameter frequencies of the ova it is believed that *Oligocottus maculosus* spawn several times in their breeding season from April through July. The maturity of the females is reached in approximately one year. In the Puget Sound area, Age-group 0 appears in the collections in June and by August its length ranges from 13 to 38 mm. In the Canadian-Alaskan area, Age-group 0 appears in late June and by the end of the year is from 16-34 mm. in length. Age-group 1 progresses to approximately 40+ mm. in length. The subsequent age-groups could not be separated by studying length frequency curves.

Literature Cited

Clark, F. N.

1928 The weight-length relationship of the California sardine (*Sardina caerulea*) at San Pedro. *Calif., Dept. of Nat. Resources, Div. Fish and Game, Fish Bull.* No. 12: 58.

1934 Maturity of the California sardine (*Sardina caerulea*), determined by ova diameter measurements. *Ibid.*, No. 42: 49.

Greeley, A. W.

1901 Notes on the tide-pool fishes of California, with a description of four new species. *U. S. Fish Commission, Bull.* 19, 1899: 7-20.

Hickling, C. F., and E. Rutenberg

1936 The ovary as an indicator of the spawning period of fishes. *Marine Biol. Assoc. of the United Kingdom, Journal*, n. s., 21 (1): 311-16.

Schultz, L. P.

1936 Keys to the fishes of Washington, Oregon and closely adjoining regions. *Washington (St.) Univ., Publ. in Biol.*, 2 (4): 103-228.

Thompson, W. F.

1915 A preliminary report of the life-history of the halibut. *British Columbia, Rept. of Commissioner of Fisheries for 1914:* N76-N99.

International Pacific Salmon Fisheries Commission, New Westminster, British Columbia, Canada.

The Experimental Stream, A Method for Study of Trout Planting Problems[1]

By P. R. Needham and H. John Rayner

WITHIN recent years many workers have been attempting to learn what happens to trout after planting. The usual method used has been to mark fish before planting by removal of fins or by tagging. Subsequent returns to counting weirs, in the case of migratory species, have formed the basis of conclusions as to survival rates. Foerster's work (1936) on sockeye salmon of the Cultus Lake system in British Columbia was the first to demonstrate the efficiency of natural propagation compared with artificial propagation of an anadromous species of fish. As is well known, the chief method employed in this work was not marking of large numbers of fish from which later total survival was determined, but to permit runs of the adult salmon to spawn naturally in some years, and in other years to strip the fish, hatch the eggs after the usual hatchery procedure, and to plant the resultant young back into the system. His method gave a measure of the difference between artificial and natural reproduction.

In streams containing so-called non-migratory, inland trout, the problem of survival leads to considerable difficulties because all adults obviously cannot be trapped at one suitable trap or weir in their parent stream. The usual method used in such waters has been to mark fish prior to planting. Later records based on anglers' catches of marked fish have been used to calculate survival rates. Much allied useful information on migration, growth rates, production per acre, condition and trends of the angling, etc., has also been produced by such experimental work.

The planting of marked fish, coupled with records of anglers' catches, leaves much to be desired. The immediate objective—survival of any given plant of fish—may be obtained with fair accuracy provided records of anglers' catches are sufficiently complete, and provided they are taken over the average life span of the marked fish planted. However, the facts thus obtained will not necessarily tell *why* any given survival rate was obtained, an answer that seems better afforded by the experimental stream method.

The gap between planting and the anglers' creel is where our greatest ignorance lies today. In the application to management problems, we have yet to evaluate the fundamental ecological elements causing losses of planted trout, be they predation, disease, temperature, food, or cannibalism. Complete records of anglers' catches on selected waters will tell the story of what a water is producing to anglers in terms of pounds or numbers of fish caught per unit of water area. But what any given water should produce on a basis of its normal biological productivity is what we should know to balance actual fish crops against potential crops in the management program.

White (1930) reported on experimental planting of trout in streams of Ontario and Prince Edward Island. He records many practical and scientific problems that confront workers attempting to determine survival rates of

[1] Published with permission of the U. S. Commissioner of Fisheries.

trout after planting. To get at such problems, the senior author in 1936 started the Convict Creek Experimental Stream, in cooperation with the U. S. Forest Service and the California Division of Fish and Game. The purpose of this paper is to describe the methods and equipment used, in hopes that other fisheries workers might find useful application in work on similar types of projects.

The Convict Creek Experimental Stream is located in the Sierra Nevada Mountains in Mono County, California, at an elevation of 7,200 feet. It is in the Inyo National Forest, about forty miles north of Bishop. Convict Creek was chosen because it is a typical meadow-type trout stream which flows eastward from the Sierras. It is crossed by the main Los Angeles–Reno highway and is near several summer resorts, which make for heavy fishing in the stream during the open season. Most of the fish caught average close to seven inches in length and are for the most part brown trout, with a few cutthroat and rainbow occurring in the catches. The creek has an average width of about twelve feet and an average depth of about one foot over the summer period. It is an excellent trout stream with fair cover and food. Its average summer temperature is approximately 60° F., which is excellent for trout. No temperatures of over 70° F. were recorded.

Convict Creek rises in snow-fed lakes near the crest of the Sierras, plunges precipitously down a canyon, dropping nearly 2,000 feet into Convict Lake. From here the stream drops about 800 feet in two miles to the experimental area. In 1937 the flow in Convict Creek proper reached approximately 100 cubic feet per second at the experimental area during the period when snow was melting rapidly in the higher altitudes during the latter part of June and decreased to approximately 20 cubic feet per second toward the end of the season. Maximum and minimum flow during past years are 227 c.f.s. in June, 1932, and 1.8 c.f.s. in October, 1930.[2]

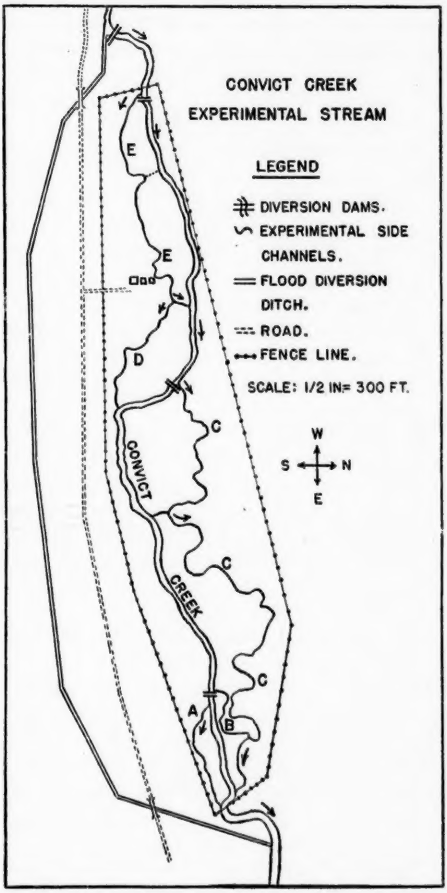
The Physical Plant

Because floods prevented the use of Convict Creek proper, old overflow channels, or meanders, were adapted by diverting water from the main stream by means of log dams. Five such side channels were developed that are designated Sections A, B, C, D, and E, respectively (see map). Each of these, in turn, is divided into 100-foot to 400-foot sections by means of concrete flumes. The flumes have a 30-inch opening or sluiceway keyed for screens and flashboards. The bottom of the flumes are on a level with the stream bed. Wire cloth screens fit into keyways of the flumes and, where necessary, are packed with oakum around the sides and bottom to prevent escape or ingress of fish. Flashboards used in back of the screens serve to relieve pressure on the screens, prevent young fish from being swept against the screen, and help in keeping the screens free of debris. The lengths of the five streams are: A, 300 feet; B, 300 feet; C, 2,300 feet; D, 500 feet; and E, 800 feet.

Rubble, gravel, silt, sand, and organic detritus constitute the types of bottom present in the streams. Grass, branches, logs, roots, overhanging willows, and undercut banks form most of the cover. Several sections were

[2] A flood control diversion ditch was completed in October, 1938. (See map.) It will now be possible to divert peak flood waters around the experimental area.

not used in 1937 because of unnatural or poor conditions obtaining. In a few cases two or three sections were used as one. Conditions throughout the streams were as near to natural as possible, and the only unnatural condition was the dams separating the sections. A five-strand barbed-wire fence was put up to keep stock out of the area, which is about 55 acres. Along the fence, at 100-foot intervals, are signs indicating that the area is closed, and these signs have been respected by fishermen.



Each experimental section is, then, in essence, a "controlled" stream in which such factors as sizes, numbers, species, fish predators, and shelter may be modified and the quantitative effects on trout populations can be measured in terms of survival. Control of such ecological factors as food, water temperatures, and terrestrial animal predators, is not completely possible nor

desirable. The experimental plants are made in exactly the same way any person might plant any given stream with trout; the only difference is that the fish are marked and confined to specific areas, under certain specific conditions. Likewise, they are followed through the growing season, and all survivors along with wild fish normally present, can be taken at the end of each operating season.

At present no fishing by anglers is permitted in the experimental sections and all results obtained to date, therefore, have not been affected by this factor. Eventually it will undoubtedly prove desirable to carry on specific experiments where this element should be introduced, in which case it will be carefully controlled to fit the requirements of the investigative program.

Operating Procedure

Construction work was partially completed in the fall of 1936 and the project was first operated during the summer and fall of 1937.

Much of the first season's work was spent developing a technique. Operation problems are complex and varied in an experimental stream and each must be solved, or the experimental program modified accordingly. Unless prevented, accidents of all kinds can occur that will nullify any experimental results obtained. Full-time supervision is essential. Throughout the season it was necessary to keep the screens free of debris to prevent overflow and to guard against the backing up of water with attendant loss of fish through stranding. One man was hired to perform this duty. Rain and excessive winds sometimes made screen-cleaning a continuous task. Ordinarily the screens were cleaned at 7:00 and 10:00 A.M. and 1:00, 4:00, and 9:00 P.M.

Although stationary screens have been used thus far, rotary screens are preferable because they reduce the manual labor of frequent hand cleaning with brushes, and tend to prevent fluctuations in flow of water. As screens become clogged, particularly at the take-outs where water is diverted from the main channel, the flow is likewise reduced. Cleaning increases the flow again, and the unnatural condition produced by such fluctuation has bad effects on the fish, their food, and other ecological conditions within the experimental sections. Fortunately Convict Creek water, except during flood periods in the spring, is fairly free of organic detritus in suspension.

The fish planted in the various experiments are marked by removal of fins. This procedure is highly essential to distinguish wild trout normally present from planted experimental fish, both during operating periods and after netting operations in the fall. The fins removed in marking are usually either one or both pelvics, or pectorals, and the adipose. Some regeneration of the fins removed takes place over the field season, but characteristic malformation of regenerated fins makes later recognition easy. After marking, all fish are held in tanks for several days so that any injured in the process may die and be removed prior to planting to avoid error in the experimental results obtained.

Adult trout of large size can be planted in any experimental section where it is desired to vary the predation factor. In the study of predation and its effects on survival rates of planted trout, it will be necessary to determine the size at which trout become predators. This will involve both the avail-

ability of smaller fish and abundance of invertebrate food organisms. In the selection of predator trout for use in planting experiments to date, only those of large size have been used that could be depended upon to consume small, freshly planted trout that might be available.

Prior to planting in 1937, where it was desired to remove wild trout, various sizes of seines were used. A small hand seine, well weighted with leads and with plenty of bag, proved most useful. Even with this type of net, it was not possible to remove all wild fish. For instance, in order to estimate the number of wild fish in one experimental section prior to planting in 1937, the latter was thoroughly seined before stocking, and it was judged that approximately fifteen fish were present. After pumping the section completely dry in the fall, 108 wild brown and rainbow trout were recovered! This gives a good idea of the error that may result from observations based on supposedly quantitative seine hauls from given lengths of streams.

To drain any given section completely so as to collect the trout at the end of the field operating period, a self-priming gasoline pump is used. This method proved much more efficient than seining and is far superior to it. A pump delivering about 140 gallons per minute is used.[3] It is fitted with 12 feet of suction hose and 100 feet of delivery hose in two 50-foot pieces. In using it, the water is cut down to a small flow at the take-out gate from the main stream. This keeps both the fish and their foods alive in upper sections while a lower section is being drained. The pump is then moved upstream, from pool to pool, draining each along the way. The riffles naturally drain themselves into each pool. By placing flashboards in the flume at the head of a section for short periods, the flow can be stopped entirely. The fish are collected and placed in live-cars after each pool is completely drained.

Poisons were not used to remove fish because they have not been developed to the point where one can know with certainty the full toxic effect on either foods or other ecological conditions.

Period of Operation

Winter conditions on Convict Creek permit only seasonal operation of this project. Heavy snow storms occur, which, with low temperatures, make it impossible to maintain screens and free flows of water in the sections. On an inspection trip made to the area in February, 1938, all the side channels and most of the main stream were frozen over. Snow about three feet deep with scattered drifts even obliterated the stream channels in many places.

In the season of 1937 the planting experiments were operated for a period of approximately 75 days. In the 1938 season this was extended to an average of 90 days. Though seasonal, such investigations include the principal growth, reproductive, and angling periods of the year. Difficulties of getting fish of the sizes needed for the planting experiments early in the season, unsatisfactory road conditions, and bad weather all serve to limit the period of operation. Since year-round operation is impossible, this fact will have to be carefully weighed in relation to the analyses and application of

[3] For population studies in small streams or streams where a large portion of the flow could be diverted, a light, portable pump, used to drain the pools completely, would certainly give far more accurate quantitative results than seine hauls. It would also prove useful for draining side flood-channel or tidal pools to catch stranded fish.

the data obtained. Repetition of the individual experiments will be necessary from year to year to check the consistency of results.

Food Studies

To determine the foods present in the experimental stream sections, both stream bottom samples and stomach contents of trout are studied. The bottom samples show the relative richness of aquatic food, and the stomach analyses provide a comparison of aquatic and terrestrial foods that are eaten. Both stomachs and bottom food samples are taken throughout the operating season to permit comparison of foods eaten with those available during the greatest period of growth.

A large number of bottom samples were taken both in the main stream and in the experimental sections that were representative of the principal types of aquatic habitats in each. These make possible a direct comparison of foods present in each, as well as within specific habitats in each. By taking a large number of samples, errors caused by sampling methods and by other factors may be considerably reduced.

Stocking Policy

During the first season of operation the experimental sections were stocked after Embody's tables (1927). The numbers planted were varied from one to one hundred times that recommended by Embody. This was done to gain an idea of the optimum numbers that should be planted under varying conditions in a typical east slope stream such as Convict Creek. The food, width, length of section, and riffle and pool value were the factors determining the numbers of the various sizes of fish planted. These values varied as it was thought necessary to establish a separate stocking policy for each section.

Last season (1938), instead of using a separate stocking policy for each section, the same policy was used for all, based on the same value of food and stream conditions. Through the aid of C.C.C. labor early in the spring, all sections were made as nearly alike as possible as to shelter by improving the poor ones. Although no two sections can be made precisely alike as to shelter, food, width, pools, or other ecological conditions, it is felt that they all are now as similar as they can practically be made and are sufficiently so to justify use of the same stocking policy for all sections. Numbers planted in any given section or combination of sections will, of course, be varied according to length and average width of the stream used.

Eventually a stocking policy will be developed based on the experimental results obtained. The policy recommended by Embody (1927) has proved suitable in some of the experiments. The number of wild trout naturally present in the sections prior to planting may, in some instances, already be close to optimum population density and planting additional hatchery fish may therefore upset the balance. Embody did not intend that his policy should cover all streams in the United States, but felt it was suited for those streams in central New York State where fishing is so intense that the trout population is decimated seasonally, and where natural spawning contributes but little to fish populations. Since Embody's policy recommends planting

larger numbers of fish for intensively fished waters, next season, the policy recommended by Davis (1938) will be tried since it advocates the planting of fewer fish for less intensively fished waters.

Condition Factors

The condition factor of a random sample of each lot of fish to be planted is taken at the beginning of the season and based on fish weighed and measured when fresh, prior to preservation in formaldehyde. All surviving experimental fish, or samples of them, are likewise weighed and measured fresh. Thus errors caused by preservation in formaldehyde are avoided. The condition factor is used as one measure of the efficacy of the stocking policies used.

General Observations

As stated above, the most important outcome of the 1937 season was the development of an operating technique. Because of the nature of the problem, the experimental results obtained to date must be considered tentative until further studies made over a period of years substantiate them. The biological results indicate that hatchery fish do well in wild water. Their mortality has been surprisingly low in many instances despite the presence of predators. As reported by other workers, hatchery fish have lost weight after planting, resulting in low condition factors. It would be an exceedingly rich stream that could support the ordinary run of hatchery fish so that they retained their hatchery condition factor. However, hatchery fish of the stock used in 1937 and planted in July were caught in the main stream in the experimental area one year later in July, 1938, and were in excellent condition, showing that they had adjusted themselves to the environment.

Eyed eggs, advanced and yolk-sac fry suffer heavy losses when planted into the experimental stream. The egg and fry plantings have been only partially successful because of heavy silting and other conditions. The requirements for the successful experimental planting of trout eggs are many, and varied and numerous unpredictable events can occur to nullify such experiments.

Allied Problems

The experimental stream seems to offer definite possibilities for the study of numerous other types of field problems aside from those relating solely to survival of hatchery fish. Among such is the study of natural spawning. Adult spawners could be stocked in sections affording good natural spawning areas, and the qualitative and quantitative results of natural spawning could be observed under rigidly controlled environmental conditions. Our observations at Convict Creek to date have shown a surprisingly large number of naturally spawned fish to be present in all the experimental sections; and, as the work gradually progresses, it is apparent that natural spawning will have to be studied in any basic problem relating to a study of stream productivity.

Natural trout food studies relating to such problems as distribution, sampling, availability to trout, rates of replacement, etc., cannot be carried on indoors, and here too the experimental stream could be used. In addition, studies on nutrition problems under normal stream conditions offering full

control, might well be undertaken; likewise, studies on fundamental differences between wild and hatchery-reared trout.

Through the media of the experimental stream, a start has been made in developing what amounts to a stream fisheries laboratory. Since obviously aquaria or other indoor types of laboratory equipment are impractical for trout planting experiments, the only alternative is to go outdoors where natural stream conditions can be had and where suitable "environmental control" can be exercised. Analysis and weighing of the ecological factors affecting survival of fish planted from hatcheries require such equipment as only a natural, wild stream can provide; and the relative survival values obtained from repeated experiments wherein primary ecological factors are intentionally varied will certainly prove more useful in application to planting practices than the former guesses commonly used as a basis for stocking streams.

Acknowledgements

The writers are indebted to the following agencies and persons for much aid given in the course of the development of the Convict Creek Experimental Stream: Mr. Elmer Higgins and Dr. H. S. Davis of the U. S. Bureau of Fisheries; Mr. F. N. Cronemiller, Mr. Fred Johnson, Mr. Roy Boothe, and Mr. Reed Neilson of the U. S. Forest Service; and the staff of the Bureau of Fish Conservation of the California Division of Fish and Game.

Bibliography

Davis, H. S.
1938 Instructions for conducting stream and lake surveys. *U. S. Bur. Fish., Fish. Cir.* 26: 44 pp.

Embody, G. C.
1927 An outline of stream study and the development of a stocking policy. *Contrib. Aquiculture Lab. Cornell Univ.*: 21 pp.

Foerster, R. E.
1936 Sockeye salmon propagation in British Columbia. *Biol. Bd. Canada, Bull.* LIII: 16 pp.

White, H. C.
1930 Trout fry planting experiments in Forbes Brook, P. E. I. in 1928. *Contrib. Canad. Bio.*, 5: 205–211.

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A New Stomiatoid Fish from California

By Rolf L. Bolin

THROUGH the courtesy of the California State Division of Fish and Game I am occasionally able to make deep plankton tows from state patrol boats. In such a haul taken on May 24, 1938, from the patrol boat "Albacore" there occurred an interesting stomiatoid fish of a new generic type.

Tactostoma, new genus

Type.—*Tactostoma macropus*, new species

Body long, slender, *Leptostomias*-like. Head small. Mouth curved; dentary bent upward, protruding well beyond tip of non-protractile premaxillary. Anterior teeth with a minute, rudimentary, sub-terminal cusp, so that their tips appear truncated, but none definitely bifid. All teeth within the mouth depressible; arranged in linear groups with those in each group graduated in length; the groups of the lower jaw strongly oblique. A few, small, fixed, external teeth on outside of upper jaw, followed by depressible ones. No teeth on vomer nor palatines. A series of strong teeth on tongue. Origin of dorsal and anal fins on same vertical. Anal fin slightly longer than dorsal. No pectoral fins. Ventral rays 10.

Individual external characters of the species described below, suggest its relationship to several different genera. In general body form and number of photophores it is very similar to the species of the genus *Leptostomias;* the lack of vomerine teeth suggests *Lamprotoxus* and *Bathophilus*; the lack of palatine teeth suggests *Opostomias* and *Eustomias*; the 10 ventral rays are found in related forms only among certain species of *Bathophilus;* and the missing pectoral fins indicate relationship to *Photonectes*. In each case, however, the evidence of relationship is outweighed by dissimilarities of greater importance.

Tactostoma is probably most closely related to *Photonectes*, but it appears to merit generic isolation because of its attenuated body form, its marked differences in dentition, its strikingly increased number of ventral rays, and its exceedingly numerous photophores.

Tactostoma **macropus**, new species

Body long, slender, its greatest depth 11.1 in standard length. Head small, 8.8 in standard length. Mouth large, about 0.6 of maxillary lying behind a perpendicular to upper jaws drawn through posterior margin of orbit; lower jaw about 1.1 in head. Upper jaw with 36 teeth; lower jaw with 54. Premaxillary teeth arranged in groups of 5, 6, and 6; the first 1 or 2 teeth of each series displaced somewhat laterally and dorsally so that they occur definitely on the lower part of the cheek instead of in the mouth proper; first tooth in each group fixed, remaining teeth depressible. Teeth in each series progressively increasing in length posteriorly, or first tooth slightly larger than second. Largest tooth about 0.7 diameter of orbit. Maxillary teeth similar but somewhat smaller, in groups of 5, 6, 6, and 2. Two teeth in the first group, 3 in the second, and 4 or 5 in the third series

are external to the mouth; anterior teeth in each series fixed, posterior ones depressible; last tooth in maxillary is a minute, firmly fixed denticle, directed downward and backward. Dentary teeth all depressible, arranged in oblique series with the anterior teeth of one series lateral and ventral to the posterior teeth of the preceding series. Teeth in groups of 1, 3, 5, 3, 4, 5, 5, 5, 5, 5, 6, 5, 2; those in each series increasing progressively in length posteriorly, with the exception of the first 4 or 5 groups where the next to the last tooth may be the longest one of the series. Longest dentary tooth about equal to diameter of orbit. Tongue with a linear series of 7 fang-like teeth on each side, divided by a wide interspace into an anterior group of 4 and a posterior group of 3. Barbel short, simple, its length slightly less than diameter of orbit (possibly broken).

Fin formula: D. 16; A. 20; V. 10. Ventral base about midway between 17th or 18th O-V photophore and base of caudal fin; fin rays very delicate, most of them broken but fin extending at least to 11th V-A lateral. Dorsal origin about midway between 4th V-A lateral and base of caudal; base of fin about equal to length of upper jaw. Anal origin directly under dorsal origin; anal base slightly longer than length of head. All of the central rays of the median fins are broken and the heights cannot be determined. Membranes of median fins thin and transparent. Caudal fin markedly uneven, the lower lobe longer, and with larger and more robust rays than the upper.

MEASUREMENTS IN PER CENT OF STANDARD LENGTH

Length of head	11.4
Diameter of orbit	2.0
Length of snout	2.7
Length of maxillary	9.2
Length of lower jaw	10.3
Depth just behind head	5.4
Greatest depth (about midway between snout and ventrals)	9.0
Depth at ventral base	5.8
Dorsal origin to anal origin	4.8
Least depth of caudal peduncle	2.5
Snout to ventral	65.5
Width of ventral base	2.3
Snout to dorsal	83.7
Dorsal base	9.3
Snout to anal	83.4
Anal base	12.1

A large suborbital photophore with a deeply embedded, globular lens. The lens, slightly larger than the pupil of eye, is directed forward and slightly outward and upward, its posterior part covered by a dense, black, pigment layer. A prominent superficial luminous area, bluntly triangular in shape, in front of upper anterior margin of orbit; an elongated oval area under anterior part of orbit, and a smaller sub-oval patch between and slightly anterior to these. Another somewhat diffuse triangular area behind upper posterior orbital margin. About 4 or 5 similar but smaller diffuse patches on opercle at level of lower margin of orbit and 3 or 4 still smaller ones on lower part of opercle. These grade into numerous small round spots, appearing like mucous pores, which are scattered thickly and irregularly over entire head, becoming most prominent on the comparatively light-colored posterior portion of lower

jaw, where their black rims are very conspicuous. A moderately well developed photophore on lower posterior part of opercle. A series of 12 photophores along margin of branchiostegal membrane.

Photophores in lateral body series: O-V 43, the first one over the 12th I-V organ; V-A 18; A-C 12, the series an even continuation of the lateral V-A series, the last 2 organs behind anal base and somewhat more widely spaced than preceding organs. Photophores in ventral series: I-V 54, the first 8 on isthmus; V-A 19, the last 3 over anal base. In addition to the main series of photophores, the body is studded with small luminous flecks, which form irregular bands crossing the back and extending ventrally to a point slightly dorsal and anterior to each photophore of the lateral series. Below each of the lateral photophores a group of somewhat larger luminous spots forms a vertical band which expands ventrally and tends to merge with adjacent bands a short distance above the ventral photophores. The ventral organs are bordered ventrally by dense semicircular masses of luminous spots. Membranes of all fins studded with small luminous patches, crowded near the bases of the fins, more widely scattered distally.

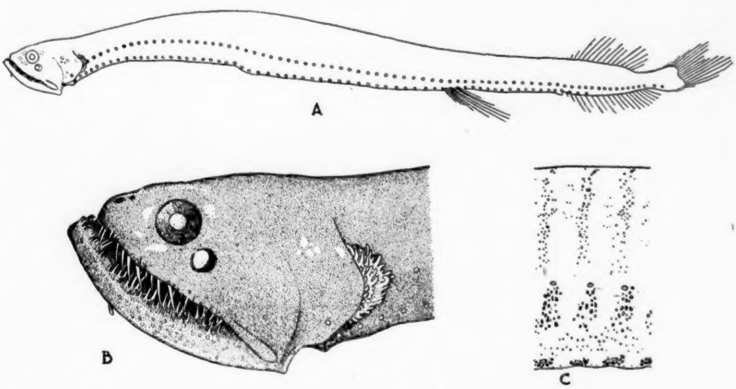


Fig. 1. *Tactostoma macropus*, new species. A. Holotype, 71 mm. in standard length. B. Head of holotype. S. Section of body between head and ventral fins, showing arrangement of the small luminescent spots in relation to the photophores.

Color soft velvety black except for posterior part of lower jaw which is dark gray. Before preservation the suborbital photophore was a pale luminous green.

The holotype and only known specimen is 71 mm. in standard length. It was taken off Monterey Bay, California, Lat. 36° 42′ N., Long. 122° 03′ W., with 900 meters of cable out. It is in the collections of the Natural History Museum of Stanford University.

Hopkins Marine Station, Pacific Grove, California.

Suggestions on the Evolution of the Operculum of Fishes

By Theodore H. Eaton, Jr.

THE acanthodians had a complete open gill cleft between the palatomandibular and hyoid arches (Watson, 1937). For all fishes believed to have this character Watson proposed the class Aphetohyoidea and placed in it also Arthrodira, Antiarchi, Petalichthyida and Rhenanida. The class, if accepted, stands at the base of the gnathostomes.

An operculum was present in acanthodians, attached to the palatomandibular arch and consisting ordinarily of a series of slender bony plates in a flap of integument. It became largest in the later genera (e.g., *Acanthodes*) and reached across the lower parts of all the gill clefts, including that in front of the hyoid arch.

The acanthodians became extinct in the Permian. According to Watson it is not likely that any other known fishes descended from them because their fin spines and basal fin cartilages are too specialized and the lateral line is clasped in a unique manner between elements of the dermal armor. Because of these features we cannot suppose the higher fishes to have come directly from any acanthodian so far as known.

The operculum of modern fishes, taken in its entirety, seems to be primarily related to the hyoid arch. For present purposes "operculum" will mean the integumental flap covering the gill clefts, with all its included dermal bones, arteries, veins, nerves and muscles. Likewise "modern fishes," for present purposes, may be stretched to include all except Aphetohyoidea (above defined), elasmobranchs and Agnatha. The object of the present paper is to compare the operculum of acanthodians with that of modern fishes, and to see whether any elements of the latter may have a mandibular origin; that is, whether the modern type of operculum may go back to an aphetohyoidean ancestry or whether it is wholly independent of the mandibular type.

Since there was a distinct increase in size of the acanthodian mandibular operculum from the early genera to the later ones, it is probable that an enlarged one like that of *Acanthodes* did not occur in the common ancestor of the acanthodians and the earliest modern fishes (e.g., Crossopterygii, Dipnoi and paleoniscoids). But in most cases the operculum was large enough to reach across the ventral parts of the gill clefts, and in the primitive genera particularly it contained bony rays and numerous smaller scales (Watson: 118). It is probable, too, that the acanthodians approached modern types more closely than did any other group which Watson has placed in Aphetohyoidea.

Reduction of the hyoid cleft to a spiracle resulted from a close connection of the mandibular arch with the hyoid arch by ligaments or by direct articulation or both. There is no reason why this could not have happened

independently in different descendants of Aphetohyoidea, for example elasmobranchs on one line and Osteichthyes on another (Watson), and this would mean that the hyostylic jaw suspension of the two was also reached independently (DeBeer, 1937). This change in either case was brought about by increased functional importance of the jaws. Whereas ancestral gnathostomes had relatively short jaws, with eyes near the tip of the snout and brain well forward in the cranium, the enlargement of the mouth in later forms caused the angle of the jaws to recede at the expense of the hyoid cleft, and the anterior end of the head to be more and more produced in front of the eyes. This seems to have resulted in an apparent recession of the eyes and brain and even of the roofing bones of the head. (For more discussion of this point see Romer, 1937; Westoll, 1936.) One of the first consequences, however, was the obliteration of the hyoid cleft ventrally, leaving only a spiracle in front of the arch. A mandibular operculum, if present, could then have become attached to the hyoid arch. As the jaws became more distinctly different in structure and function from the other visceral arches it might be an advantage to have their movement more completely freed from that of the operculum; this could readily be accomplished, and also give a more stable support for the operculum, by the latter articulating with the hyoid bones. Perhaps enlargement of the jaw muscles would contribute to the displacement of the operculum backward (W. K. Gregory, in letter) although this does not presuppose a mandibular operculum.

Among paleoniscids some of the genera agree with acanthodians in having the palatoquadrate and Meckel's cartilage each in two pieces. The form of the head, body, heterocercal tail and ganoid scales is strikingly like that of acanthodians, but the fins are those of teleostomes and the hyoid cleft is reduced to a spiracle. The opercular series of dermal bones fits closely behind the jaw (Goodrich, 1930; Gregory, 1933), although the internal elements to which they are attached are apparently those of the hyoid arch. The opercular and subopercular bones hinge on the hyomandibular after the usual fashion of teleostomes, but it is not yet known whether the ventral pieces of that series attach to the ceratohyal and hypohyal as they do in higher fishes (D. H. Dunkle, in letter). On the surface of the hyomandibular, in a narrow gap between the preoperculum and operculum proper, occur slender dermohyal bones in at least a few genera (Nielsen, 1936). It is at least possible that, instead of being cenotelic features of paleoniscids, these are a heritage from an ancestor whose dermal head-armor consisted of smaller and more numerous elements, especially as an apparently corresponding piece occurs in *Polypterus.*

From paleoniscids up through amioids and teleosts there appears to be a recession of the whole opercular series away from the palatomandibular arch. The interopercular retains a direct connection with the mandible by a more or less lengthened tough ligament. This might be interpreted as a cenotelic character giving additional jaw support, and perhaps that is its function, but ligaments do not ordinarily develop between bones where there has been no previous direct contact. This is certainly not a left-over muscle-tendon. Furthermore it is a stable feature in living fishes from the Holostei

even to such an extreme teleost as *Mola*. Thus it seems that we have here a relic from the time when the opercular bones were closely attached to the dermal jaw bones.

The arrangement of the series of opercular bones in acanthodians shows that even with the mandibular operculum, a functional distinction existed between the free part of the opercular flap and the ossicles or scales covering the jaws. The anterior edge of the free portion of the operculum probably coincided more or less with the anterior edge of the row of slender parallel bones it contained. In front of these in turn was the preopercular sensory canal, which continued out on the lower jaw as the mandibular canal. These canals occupy the same positions morphologically in modern fishes, such as *Osteolepis, Amia, Gadus,* etc., and are considered to be homologous throughout (Watson). Thus the preopercular canal may be taken, whether in acanthodians or modern fishes, to mark roughly the boundary between the operculum as a whole and the dermal bones of the upper and lower jaws, for just behind the canal in either case is a line of hinge movement for the operculum. To this extent it appears that the acanthodian operculum is the same as that of higher fishes.

What about the position of the spiracle? In paleoniscids, amioids, Polypterini, etc., it is decidedly anterodorsal to the operculum, just as one might expect if the latter had originated in place on the hyoid arch. But in no instance does the preopercular canal descend behind the spiracle; it may be interrupted or bent, but there is nothing to indicate a connection with the horizontal canal via the hyoid region. The seventh or facial nerve we associate with the hyoid arch, and this innervates the preopercular canal; but this is quite irrelevant since the same nerve supplies the other sensory canals of the jaws, snout and elsewhere on the head; it is only the motor division of the seventh nerve which is hyoidean.

This brings us to the muscles of the operculum. In the embryo of any generalized vertebrate the visceral arch muscles (including those of the jaw) develop as slender bands or constrictors, running up along the arches from the embryonic pericardial mesenchyme (Edgeworth, 1935). From these constrictors several different muscles are formed early in development, but in the hyoid and succeeding arches a part remains to make the adult constrictor along the outer face of the arch. In the jaw arch, however, the constrictor is sacrificed wholly to make the jaw muscles. One division of it (levator palatoquadrati or constrictor dorsalis) extends from the cranium to the palatoquadrate in those types which have a movable palatoquadrate. Another division (adductor mandibulae) runs from the palatoquadrate to the mandible (Meckel's cartilage), that is, from the upper to the lower jaw. A third (intermandibularis) goes from Meckel's cartilage to the midventral line, where it meets its fellow from the opposite side, and often forms a single transverse sheet. Now in the hyoid arch there develops a levator hyoidei, serially homologous with the levator palatoquadrati, and certain other muscles which need not concern us here. But a part of the embryonic constrictor also remains, forming a large sheet of muscle running from the skull to the midventral line along the inner face of the operculum, and known variously as constrictor hyoidei, opercularis, etc. It is particularly strong

in Dipnoi, *Polypterus,* and, from the writer's study of *Megalichthys* material, the crossopterygians.

The reason why a corresponding constrictor sheet does not exist in the adult jaw arch of any modern fishes is clear enough. The attachment of the jaws to the hyoid arch has crowded out all available space for it, and there is nothing movable which is not already moved by one of the divisions mentioned. But in acanthodians the situation was otherwise. Undoubtedly those three divisions were present, since the skeletal parts had the proper relations, but it is entirely possible that the jaw constrictor also persisted here to move the operculum just as the hyoid constrictor does in modern fishes. The cleft was wide open, and the operculum probably would not have depended on its own elasticity for opening and closing. This muscle, like the other jaw muscles, would of course have been supplied by the fifth nerve. No actual evidence is yet available for such a mandibular-opercular muscle, but, with the above points and the one which follows considered, it seems reasonable to think there may have been one.

In *Polypterus, Lepidosteus, Amia* and the teleosts there is a dilator operculi innervated by the fifth nerve and the developing from the levator palatoquadrati in the embryo. It would be difficult to explain such a muscle on embryological or morphological grounds if the operculum is wholly hyoidean in these higher fishes, especially as the first three named still have a spiracle present. But if this muscle is a heritage from one which moved the mandibular operculum in an aphetohyoidean ancestor, its developmental position is clear.

We may summarize this possible history of the operculum of modern fishes as follows:

1. Somewhere among Watson's proposed class Aphetohyoidea, and rather near the base of the acanthodians, was a fish with a mandibular operculum. The possibility that this operculum corresponded with a part of the cephalic shield of the other armored types, and was thus morphologically present in all of them, should not be overlooked.

2. From this could be derived either the exaggerated type found in advanced acanthodians or that of modern fishes.

3. In order to account for the latter we should consider the ventral closing of the hyoid cleft, leaving the spiracle open above and the jaws closely articulated with the dorsal part of the hyoid arch. This would not notably affect the integumental or bony components of the opercular flap, except that the dorsal bones probably articulated with the hyomandibular at about the time hyostyly began. This would be a simple mechanical convenience, since no water from the prehyoid cleft could now pass under the operculum, and the latter was free to avail itself of a more stable support than that provided by the jaws.

4. A mandibular constrictor muscle, if present before, would now have atrophied except for a dorsal portion which persisted as the dilator operculi. The constrictor hyoidei, previously almost identical with the branchial constrictors, was now available to move the operculum from within.

5. The requirement of a hinge between the opercular series and the jaw series of dermal bones already existed, but now the former series, from the

opercular bone itself down through the branchiostegals, closely overlay the entire length of the hyoid arch, and had only to attach there in order to be relatively independent of the mandibular series.

In this way the apparently hyoidean operculum of modern fishes might be conceived as having a dual origin. Its integumental and skeletal elements plus the dilator muscle may be from the mandibular operculum of a pre-acanthodian. The constrictor muscle and the articulations of the skeletal parts are hyoidean.

This hypothesis reconciles the two types of operculum with each other and does not disagree, so far as the author has discovered, with any pertinent paleontological, embryological or morphological facts. But it is given only as a suggestion, and may prove to be unsatisfactory in some ways. The writer believes that more conclusive evidence will not come from the study of such specialized fishes as teleosts, modern Dipnoi, or even Holocephali, but from the embryology and paleontology of the most primitive available forms.

Literature Cited

DeBeer, G. R.
1937 The development of the vertebrate skull. *Oxford, The Clarendon Press.*

Edgeworth, F. H.
1935 The cranial muscles of vertebrates. *Cambridge Univ. Press.*

Goodrich, E. S.
1930 Studies on the structure and development of vertebrates. *Macmillan and Co., London.*

Gregory, W. K.
1933 Fish skulls: a study of the evolution of natural mechanisms. *Trans. Amer. Phil. Soc.*, 23(2).

Nielsen, E.
1936 Some few preliminary remarks on Triassic fishes from east Greenland. *Medd. om Grøn.*, 112(3): 1–55.

Romer, A. S.
1937 The braincase of the Carboniferous crossopterygian *Megalichthys nitidus. Bull. Mus. Comp. Zool.*, 82(1): 1–73.

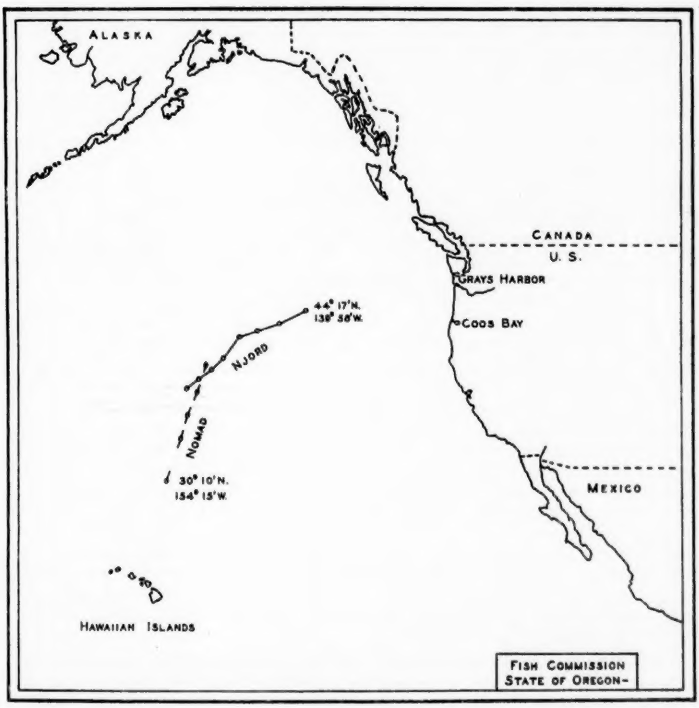
Watson, D. M. S.
1937 The Acanthodian fishes. *Phil. Trans. Roy. Soc. London,* ser. B., No. 549, 228: 49–146.

Westoll, T. S.
1936 On the structure of the dermal ethmoid shield of Osteolepis. *Geol. Mag.*, 73: 157–171.

Union University, Schenectady, New York.

Ichthyological Notes

OCCURRENCE OF ALBACORE (*GERMO ALALUNGA*) IN MID-PACIFIC.—During the month of June, 1937, the auxiliary ketch "Nomad" crossed the Pacific Ocean from Honolulu, T. H. to Coos Bay, Oregon. Albacore were taken from June tenth to the sixteenth; by the sixteenth the crew had a superfluity of fish and stopped fishing altogether. On June tenth the position of the boat was Lat. 30°-10′ N., Long. 154°-15′ W., and during the intervening six days she was sailed to an estimated position of Lat. 40°-14′, Long. 150° W., on the sixteenth. Five fish were caught on each of the last two days; a smaller number were taken daily during the preceding days. The last catch, that of the sixteenth, was made approximately 1500 miles from North America and 1200 miles from the Hawaiian Islands, and was almost as far offshore as it is possible to be between the Islands and North America.



The auxiliary ketch "Njord" made a similar crossing from Honolulu, T. H. to Grays Harbor, Washington, and the crew caught albacore between July eighth and July fifteenth. During this period the boat was sailed from Lat. 38°-05′ N., 152°-15′ W. to Lat. 44°-17′ N., Long. 139°-58′ W. Four albacore were taken on the first day; thereafter no record of the number caught was kept. The catches made by the crew of the "Njord" are, aside from some overlap, farther north and nearer the mainland than those made on the "Nomad." Between the first catch made on the "Nomad" and the last catch taken aboard the "Njord" lies a course of 1300 miles in a northeasterly direction.—VERNON BROCK, *Oregon Fish Commission, Portland, Oregon.*

ADDITIONAL GULF OF MAINE RECORDS OF THE WHITE SHARK *CARCHARODON CARCHARIAS* (LINNAEUS) FROM THE GULF OF MAINE IN 1937.[1] —The capture of a white shark off Swampscot, Massachusetts, on October 15, 1937, followed by a second capture on October 18 also off Swampscot, is of particular interest especially as four white sharks had already been reported from the Massachusetts Bay region this same year (COPEIA, I, 1938: 46).

The first of these October caught fish was taken in a gill net by two fishermen, Messrs. George Paris and Charles Cahoon. This shark was fully 12 feet long and weighed around 1000 pounds. Identification was made from several excellent photographs showing the entire fish and the jaws, and from a piece of tooth.

The second shark, taken by the same fishermen and in approximately the same locality, was a female, 8 feet 4 inches long, from which the following measurements were made (in inches): Snout to first gill slit 21; to fifth gill slit 27½; to origin of first dorsal 36; distance between bases of dorsals 23; second dorsal to caudal pit 9; height of first dorsal 10; second dorsal 2¼; length pectoral 21; upper caudal lobe 22½; lower lobe 17½; breadth of caudal peduncle midway between caudal pit and second dorsal 10.

During 1938, Mr. J. W. Lowes, of Harvard University, who furnished four of the six 1937 capture records, saw no white sharks, although he covered about the same fishing area as in the previous year; nor did anyone else report a white shark in the Gulf of Maine during 1938. Apparently, therefore, the visitation of white sharks in 1937 was an unusual occurrence, as all past records would indicate.—WILLIAM C. SCHROEDER, *Museum of Comparative Zoology, Cambridge, Massachusetts.*

A FROGFISH, *ANTENNARIUS TAGUS* HELLER AND SNODGRASS, FROM ECUADOR.—The American Museum of Natural History has received a frogfish (*Antennarius*) captured on the piles of a pier at Cape Santa Elena, Ecuador, in the spring of 1938, and forwarded to the Department of Fishes through the kindness of its collector, Mr. Thomas Black of Guayaquil and of Dr. Robert Cushman Murphy of the Department of Birds. It appears that none such has been previously described from the tropical Pacific coast of South America, but so many species of this genus are to be found in the literature that one suspects it is more in need of revision than of additional descriptions, and I have no hesitation in identifying this specimen with *Antennarius tagus* named by Heller and Snodgrass from the Galapagos Islands. It agrees with this fish in shape and proportions, in having 13 dorsal and 7 anal rays, body and dorsal fins thickly covered with mostly bifed prickles, and in the large bait on a slender banded stalk (or first dorsal spine), which when bent back occupies a naked pit between the second and third. Although darker and more uniform, such color pattern as shows corresponds also, namely a large oval blackish spot crossing the 10th and 11th dorsal rays near their base, which is vaguely bordered by paler, in addition to smaller less definite dark markings on the fin; and the lower parts, which are pale from the front of the ventral to the base of the pectoral and front of the anal are covered with irregularly roundish blackish spots of moderate size, which also extend onto the fins somewhat. A principal difference lies in the third dorsal spine which is quite free behind, seemingly somewhat adnate in the figure of *tagus*. There is a peculiar pale oval area or spot with a narrow submarginal dark ring above each pectoral.—J. T. NICHOLS, *American Museum, New York City.*

A RECORD OF *GOBIOMORUS DORMITOR* FROM FLORIDA FRESH WATER. —On a collecting trip into the northern Everglades region in March 1934, I took while bass fishing a specimen of *Gobiomorus dormitor*. The body of water from which the fish was taken was one of a series of small marshy lakes about 18 miles west of Jupiter, Florida. This goby, also known as the Guavina del Rio, rose from the bottom to take the slowly moving artificial bait. The specimen measured just under two feet.

Subsequent examination of these lakes revealed no currents, and to all appearances they were completely landlocked. The water at the time, however, was low, and it is not unlikely that these low-lying lakes overflow at flood time and eventually drain to the Loxahatchee River. This is significant if one attempts to explain the presence of

[1] A previous record by William Schroeder of *Carcharodon carcharias* in the Gulf of Maine (COPEIA, 1938: 46) was combined with a record of *Pseudopriacanthus altus*, from Cohasset, Mass. This was an editorial error; the two notes should have been separated.—ED.

Gobiomorus dormitor so far from its previously known range. Jordan gives as the range of this species the Atlantic coastal rivers of Central America and the West Indies.

I wish to express my thanks to Dr. J. T. Nichols for having confirmed identification of the specimen. The mounted specimen was given to the American Museum of Natural History.—J. T. SACKETT, *Newport, Rhode Island.*

HELIOPERCA IN NEW YORK HARBOR.—Since 1920 it has been the custom of the New York Aquarium to record, with annotations, the species of fish occurring in New York Harbor. Most of these records have appeared in COPEIA. As no new species have been noted since 1934, it was felt that few would be subsequently added. Consequently a review article[1] was published with a full bibliography discussing the situation in the early part of 1938.

Following the visitation of a West Indies hurricane to the New York region on September 21, 1938, the fresh-water sunfish, *Helioperca macrochira* (Rafinesque), appeared in the commercial pound nets of Sandy Hook Bay. These fish had been clearly dislodged from the streams draining into the Bay, undoubtedly by the forces of the hurricane and deluge. One specimen brought to the Aquarium on October 12 was still in a living state, although it subsequently died. Presumably it had sojourned in salt water for about twenty days. The specimen measured 17 cm. in standard length and is deposited in the American Museum of Natural History as A.M.N.H. 14170.

The finding of this species brings the total number recorded from the harbor to 130. It represents the only distinctly fresh-water form accidental to the list, other more or less fresh-water species therein all normally wandering into the sea at times.

The only other items of general interest since the last publication on this region include the appearance of an unusually large number of *Alutera schoepfii* (Walbaum) in 1936 and 1937 and the appearance in 1936 of two small *Tarpon atlanticus* (Cuvier and Valenciennes) measuring less than 1 meter.—C. M. BREDER, JR., AND R. F. NIGRELLI, *New York Aquarium, New York City.*

Herpetological Notes

THE PYGMY SALAMANDER *DESMOGNATHUS WRIGHTI* KING, ON WHITE TOP MOUNTAIN, VIRGINIA.—On June 5, 1938, while collecting on White Top Mountain, Virginia, I took one specimen of *Desmognathus wrighti* as it was running over the top of a small rock. The specimen was taken about 7 P.M. just before dark. Although collecting was continued until 11 P.M., during which time a thorough search was made under bark, fallen logs and stones, no more specimens of this species were taken.

The specimen, which has been deposited in the Carnegie Museum (CM 14257), is an adult male with the following measurements: total length 44 mm; head 5, body 20, tail 19. It has the characteristic coloration and pattern, especially on the head, and the "herringbone" stripe down the back, which mark this species.

In addition to the one specimen of the pygmy salamander, eleven specimens of *Plethodon metcalfi* were taken. These were found climbing the trunks of spruce and hemlock trees at a distance of from two to four feet above the ground. One specimen of the terrestrial form of *Triturus v. viridescens* was found under a log. No specimens of *Plethodon welleri* were collected although Walker (COPEIA, 1934 (4): 190) records this species from White Top.

The finding of this salamander on White Top extends its range north from Grandfather Mountain, N. C., about thirty-five miles and adds another species to the list of Virginia amphibians.—N. BAYARD GREEN, *Marshall College, Huntington, West Virginia.*

[1] Breder, C. M., Jr. The species of fish in New York Harbor. *Bull. N. Y. Zool. Soc.*, 41 (1): 23–29.

HABITS OF *TRIMORPHODON VANDENBURGHI* IN CAPTIVITY.—A specimen of *Trimorphodon vandenburghi*, an adult female 26 inches long, was bought near Banning, California, on April 29, 1938. At the time of purchase it was badly injured. The snake ate a dead lizard about six inches long during the night. After arriving in Utah it was fed again on May 7 with two medium-sized swifts (*Sceloporus*). Neither of these feedings was observed. It was then placed in a large cage with an infant gopher snake, *Pituophis catenifer catenifer*, twenty-one inches long; and a desert boa, *Lichanura roseofusca gracia*, thirty-eight inches long. This cage contained a large rock, a pool of water, and a low bush. The *Trimorphodon* spent a great deal of its time in the bush, sometimes all day, with body disposed about two horizontal limbs in 8-shaped loops. With darkness, it would come down, drink daintily, and prowl.

If molested it would rear back, raising the anterior part of the body fully six inches from the ground to form a large "S," and looking very threatening. At such times it would vibrate its tail very rapidly. While it would occasionally make a feint of three or four inches, it never struck.

On May 26, the snake shed its skin. At this time its injuries had entirely healed. After shedding, it ate another swift. This feeding was also unobserved. On June 1, under a red light, at 9 P.M., a mouse was placed in the cage for the boa. It showed no signs of interest, but the *Trimorphodon* did. The mouse dug itself in under the rock, but left a crack in covering the burrow. The *Trimorphodon* stuck its head in, but withdrew with a jerk as the mouse evidently bit it. Then, displaying what appeared to be remarkable intelligence, it went on the other side of the rock and commenced digging. It displayed the technique of the typical burrower, advancing its head and neck straight, then kinking the neck, and withdrawing with soil in the loop. It made quite a large hole, then deliberately struck. Immediately there was a commotion beneath the rock, and the mouse's head appeared opposite the snake. The mouse was frantically trying to get out. During the ensuing fifteen minutes it had several spells of accelerated breathing and dazed wobbling of the head. On raising the rock, the snake was seen to have hold of the mouse's tail at the base. Several times the snake advanced its jaws, and the muscles of the temporal area bulged. When it realized that the rock no longer hampered its movements, the snake swiftly threw a coil around the mouse and began to constrict. The mouse died within thirty seconds. The snake then selected the head end of its prey and began the swallowing process. It had difficulty in engulfing the full-grown mouse, and the process took one hour and fifteen minutes.

Two days later the infant gohper snake and the *Trimorphodon* were found dead, the one evidently poisoned, the other apparently killed by constriction.—GAGE B. RODMAN, JR., *Ogden, Utah.*

RECORDS OF THE LEATHERBACK TURTLE FROM MAINE WATERS.—In a recent number of COPEIA (1938: 94) Mr. Whiteley records the occurrence and capture of the leatherback turtle, *Dermochelys coriacea*, off the Maine coast in 1937. He adds the statement that he has not been able to find any other Maine records. This gives a somewhat erroneous impression of the frequency of such occurrences in New England waters.

I reported the Maine and other New England records of this remarkable turtle in my *Turtles of New England* (Mem. Boston Soc. Nat. Hist., 8, 1919: 333, pl. 17). There were then six records from the coast of Maine, and while some were newspaper reports, these may probably be relied upon in connection with so distinctive an animal. *Dermochelys* is pelagic, a great wanderer, and not infrequently comes north in the Gulf Stream; and if shunted off into the cold New England waters becomes benumbed and liable to be captured on our coasts.

Since the publication of *The Turtles of New England*, I have learned of the following captures or observations of *Dermochelys* on the coasts of New England:

1908 off Biddeford, Me.	1928 off Chatham, Cape Cod, Mass.
1921 off Old Orchard Beach, Me.	1934 off Rockland, Me.
1921 off Isles of Shoals, N. H.	1936 off Block Island, R. I. (2 specimens)
1924 off East Dennis, Cape Cod, Mass.	1937 off West Southport, Me.

It is amusing to note that in many of the newspaper reports it is stated that "veteran fishermen" say they have never heard of such an animal before.—HAROLD L. BABCOCK, *Boston Society of Natural History, Boston, Massachusetts.*

A LIZARD LIVE-TRAP.—On a recent trip into the field one of my objectives was to bring back, alive, some whip-tailed lizards (*Cnemidophorus tessellatus*). I had tried to noose them many times before, and had succeeded in a small way, but only after expending many hours in trying.

Since on the trip in question there were other things to be done, and since I needed more whip-tails than I would have time to noose, I had to find other ways of catching them. Following many helpful suggestions given to me by my colleagues, and applying the old principle of a pitfall, I constructed a trap (see fig. 1).

The trap is 10 inches wide, 10 inches deep and 32 inches long. The trap doors in the top are made of cardboard. They are 10 inches square, and are weighted so that they balance a little more than two-thirds of the way back. This makes for quicker action than if they balanced in the middle. In use, the trap is buried in the ground, with the top flush with the surrounding surface. When a lizard crawls onto either of the doors its own weight causes the door to drop, and the lizard falls into the box. The sides are too high and smooth for the lizard to jump or climb out.

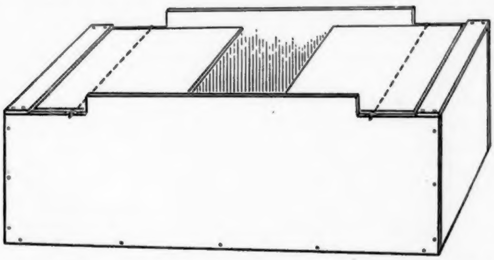


Fig. 1. Sketch of lizard trap. Dotted line shows position of center of balance of trap doors. Except for doors, which are of cardboard for lightness, one-fourth inch plywood is used.

The trap was first buried in the sand under the edge of a shrub, and a string of live meal worms was fastened to a branch of the shrub hanging over the opening of the box. It was set early in the morning, and at noon a whip-tail was in it; the next morning another, and the following morning a *Uta*. That afternoon I moved the trap to another location. The next morning I caught a *Sceloporus magister*, and the next morning another whip-tail.

Up to this time the trap had been baited with meal worms. To find out whether or not the bait was attracting the lizards, it was taken off. The next morning I caught nothing, but that afternoon I caught a skink. On the seventh day I caught nothing, but on the evening of the eighth I caught two skinks. The trap was set at 4 o'clock; one skink was taken out at 5:30 and another at 7:30. On the ninth day, with the trap set at another place, I caught another whip-tail; on the tenth day, a *Uta*, and on the eleventh a skink.

During the eleven days, eleven lizards of four kinds were caught in the trap. I felt that I was developing some skill in picking right places to set the trap, and I believe that with practice one could learn to make good sets for lizards just as an experienced trapper can for mammals. Bait, at least judging from the trials here described, seems unnecessary.

A live-trap should be a valuable aid in capturing some lizards that are difficult to noose, and possibly nocturnal forms. It would be especially valuable when making field studies which would require capturing lizards unharmed, and releasing them. The size of the trap used could be varied according to the kind of lizards sought. The trap could also be more conveniently transported if made collapsible.—THOMAS L. RODGERS, *Museum of Vertebrate Zoology, Berkeley, California.*

EXTENSION IN RANGE OF *STILOSOMA EXTENUATUM*.—Available literature indicates that the short-tailed snake, *Stilosoma extenuatum* Brown, originally recorded only from Marion County, Florida, was known until recently only from this and the

two neighboring counties, Lake and Orange. Collection of a single adult specimen 7 miles north of Brooksville, Hernando County, May 16, 1938, implies a material extension of the range of this species. The specimen was raked up among leaves and other ground litter on relatively high and dry hardwood hammock land. As a number of longtime local residents who examined it had never previously encountered the species, it is presumably rare in this vicinity. The specimen is a male with 257 ventrals and 46 caudals; total length 454 mm., tail 40 mm., greatest diameter 7.5 mm., length of head 9 mm., width of head 7 mm. The specimen is preserved in the vertebrate collection of the Withlacoochee Development Project.—Guy Van Duyn, *Bureau of Agricultural Economics, Brooksville, Florida.*

RECORD VENOM EXTRACTION FROM WATER MOCCASIN.—On April 12, 1938, a shipment of water moccasins (*Agkistrodon piscivorus*) arrived at the Mulford Biological Laboratories, Glenolden, Pa., from Stewart Springer, Englewood, Florida. One of these snakes, a male, was unusually large, measuring 60 inches in length and weighing 6½ lbs. It lived for four and one-half months, during which time its venom was extracted twice. At the first extraction (6 weeks after arrival at Glenolden) the total yield of liquid venom was 3.5 cc. After centrifuging to remove epithelial scales, the venom was dried in a desiccator under vacuum. The dried venom weighed 0.947 grams. Five weeks later the snake was again "milked" with a yield of 4.0 cc. of liquid, yielding 1.094 grams of dried venom.

A study of the venom extractions from water moccasins at the Mulford Biological Laboratories in the past five years (315 individual extractions) shows the average amount obtained from one specimen to be 0.55 cc. of liquid or 0.158 grams of dried venom. The first extraction from this large moccasin is 6 times and the second extraction is more than 7 times the average yield in terms of either liquid or dried venom. The percentage of solids in these two extractions was 27%, slightly lower than the average, which is 28%.

The minimum lethal dose (MLD) of venoms is determined by intravenous injection into 350 gram pigeons. The MLD for each of these two large extractions was found to be better than average, which is about 0.09 mgm. The MLD of the first extraction was 0.06 mgm., and the MLD of the second extraction, 0.07 mgm. If the total yield of dried venom is divided by the MLD, it can be shown that this snake yielded at each extraction sufficient venom to kill more than 15,000 pigeons.

We believe that the second extraction from this snake sets a new record for the water moccasin and compares favorably with records from any other species of poisonous snake. Stadelman reports an extraction of 4.0 cc. producing 0.864 grams of dry venom from a Florida diamondback rattlesnake (*Crotalus adamanteus*), and Klauber reports an extraction of 3.9 cc. with 1.145 grams dry venom from a Texas diamondback (*Crotalus cinereous*). The latter seems to be the world's record for highest single yield of dried venom.—Nigel O'Connor Wolff and Thomas S. Githens, *Mulford Biological Laboratories, Glenolden, Pennsylvania.*

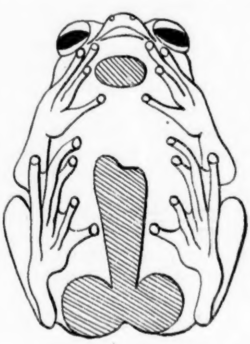
THE BARKING FROG, *HYLA GRATIOSA*, IN NORTHERN ALABAMA.—On the night of April 15, 1938, the writer, in company with three of his field staff, visited a likely looking semi-permanent pond near Hartselle, Morgan County, Alabama, in search of frogs. The pond, just at the outskirts of the town, lay in a veritable jungle of dense undergrowth. A deafening frog chorus was in progress. *Rana catesbeiana* was in fine voice; *Hyla crucifer* and *Acris crepitans* were loud; and the voices of *Hyla versicolor versicolor, Rana sphenocephala,* and *Bufo fowleri* were intermittent. Subsequent study of the specimens of *Acris* collected shows that both *A. gryllus* and *A. crepitans* were present. Above all these there came distinctly calls unlike anything we knew. In the distance they sounded like sharp explosions, popping off all over the pond. As we stood on the shore, they resolved themselves into individual monosyllabic sounds, best written "doonk." Shouting "doonk" loudly and explosively through loosely closed lips, with the tip of the tongue against the base of the upper incisors, gives a good reproduction of the calls.

The pond seemed full of the calls, but a ventriloquistic quality made them difficult to locate. We finally decided that they came from the deeper water (about 2½ ft.)

among cat-tails, and headed for them. As we moved, the voices ahead of us ceased, only to start again behind us. Finally, by triangulating the sound, we located the first frog. The spot-light revealed a floating, green, inflated, and almost circular frog with a granular skin, dark-spotted, and dotted with gold, which proved to be *Hyla gratiosa.* Five males and one breeding pair were collected. The following night eight more males were collected, and the pond still seemed as full of the barking frogs as ever; it is likely that there were at least fifty males calling as we left. The discovery of *Hyla gratiosa* in northern Alabama greatly extends its known range.

Seven of these frogs lived for some months in a glass case. They adapted themselves to captivity immediately and after twenty-four hours fed eagerly from forceps. Although they had water, sand, vegetation, and a branch upon which to sit, they preferred the vertical sides of their home like the specimens of *Hyla v. versicolor* confined with them. They ate any living insects introduced, but preferred flies, bugs, caddis flies, and butterflies and moths, if not too big to be handled. Beetles are eaten with every evidence of dislike—much contortion, blinking of the eyes, and working of the mouth and forelimbs. Earthworms are consumed readily, but with much manipulation; dead material will be eaten only when moved with the forceps.

The normal condition of the skin is somewhat dry and completely but finely granular. On occasion the color may change to the most brilliant, unspotted green, with the loss of every trace of granulation. At such times the skin appears as if enameled: slick, smooth, and very shiny, yet dry to the touch. The frogs may be of the same shade of brilliant green, but still granular; but they are never smooth in the spotted dark green phase. The appearance of the granulations seems to bear no relation to external conditions, for two individuals rarely become smooth at the same time. If disturbed, the granulations reappear in about fifteen seconds, and the shiny surface dulls.



The frogs climb about on the glass easily, and may rest for hours at a time without moving, holding to the glass by the adhesive discs on the fingers and toes. But every now and then I find them adhering to the glass by the skin of the throat and the groin. At such times the contact between the adhesive discs and the glass is broken, and the frog, completely relaxed, remains attached in this peculiar position. This condition is shown in the accompanying figure, where the shaded areas indicate contact with the glass.—A. R. CAHN, *Biological Readjustment Division, Tennessee Valley Authority, Norris, Tennessee.*

HYLA VERSICOLOR VERSICOLOR FROM SILVER SPRINGS, FLORIDA.—In 1935 Oather Van Hyning and I found a tree frog which we identified as *Hyla versicolor versicolor* in the Ocklawaha River swamp four miles east of Silver Springs, Marion County, Florida. In 1936 I again found one, and in 1937 I found another and heard two. The night of May 5, 1938, they were quite common in the swamp directly back of Silver Springs. There were about thirty around one pool of water, singing at regular intervals. One pair was found clasping on a tree above the water, and a number of males were sitting about on elderberry bushes and tree trunks. Two specimens were sent to Dr. A. H. Wright of Cornell University for examination. I believe this is the southernmost record for the species, and, since they are found north of here, believe them to be extending their range southward.

The southernmost station previously recorded for *Hyla v. versicolor,* so far as I have been able to verify, is six miles northwest of Gainesville (Van Hyning, COPEIA, 1933: 4). He states that this species is rare in the county, but that he found it breeding in that area. Our new record is forty miles farther south.—E. ROSS ALLEN, *Florida Reptile Institute, Silver Springs, Florida.*

AN EXTENSION OF THE RANGE OF *ABASTOR ERYTHROGRAMMUS*.—During the month of July, 1937, a snake skin identifiable as *Abastor erythrogrammus* (Daudin) was brought from Indian Head, Charles County, Maryland, to Dr. Doris Cochran at the United States National Museum. Since this species has not previously been reported north of Virginia, its discovery in Maryland constitutes an interesting record. Garman (1883, Mem. Mus. Comp. Zool., 8, (3): 144) cites the range as "Illinois and Virginia southward"; the most northern definite record is that of Cope (1900, Ann. Rep. U. S. Nation. Mus., 1898: 740) as on the Pamunkey River, in Virginia, which locality he refers to as "unexpected." This river is part of the boundary between King William and Hanover counties, Virginia. It flows in a southeasterly direction into the York River and is not far north of Richmond.

In April, 1938, the writer made further inquiries concerning this matter. From the project superintendent of the Civilian Conservation Corps Camp at Indian Head it was learned that three specimens of this species had been taken. All were dug from the earth during the month of July, 1937, by C.C.C. workers engaged in road building operations on Stump Neck. This area is a narrow curved peninsula, broad at the base, and about two square miles in area. It is approximately four miles southwest of Indian Head and projects west and southward into the Potomac River between the mouth of the Mattawoman Creek on the north, and that of Chicomuxen Creek on the south. The latter originates on the peninsula, and for half its length is narrow and meanders through the open marsh which forms a large part of the area. The soil is very sandy throughout. Except for the open marsh and a cultivated field, the land is densely overgrown with shrubs and trees. According to the Zone Map of the U. S. Biological Survey, 1910, this area is just across the Potomac River from, and somewhat west of, the northeastern limit of the Austroriparian Fauna.

The first specimen, the source of the above mentioned skin, was dug from sandy soil 150-200 yards from the tip of the Stump Neck peninsula. The surrounding land is swampy on the south side and verges abruptly to river bank on the north and west sides. The specimen was killed soon after discovery, and when skinned was found to contain eggs, whose number was not determined. The second two specimens, which were not seen except by the personnel of the C.C.C. Camp, were found beneath stumps along the marsh a few hundred feet southeast of the origin of Chicomuxen Creek. Both were reported to be smaller than the first. One of these was kept in a glass jar at the camp for a few days, until it died and was destroyed. The skin of the third specimen was made into a hat band which was later lost. There is no question in the writer's mind concerning the identification of the two additional specimens. They were described as exactly like the first specimen by the entire technical staff of the camp.

The headless tanned hide, in the possession of Mr. Howard Hassler, of Washington, D. C., was examined by the writer in 1938. The scale rows numbered 17-19-17; ventrals 162; caudals 36; total length 995 mm.; tail length 175 mm. At the middle of the body the markings consisted of longitudinal lines, the median row of scales light, three rows on each side of this dark, next row on each side light and more clear than median row, three rows below these dark, two rows adjacent to ventral plates light, and ventral plates each with two large dark spots near the scales. The color, faded in tanning, was dull black with dirty yellow lines.—ROBERT H. MCCAULEY, JR., *Cornell University, Ithaca, New York.*

MOTH LARVAE IN A COPPERHEAD'S STOMACH.—On August 23, 1938, a dead male copperhead (*Agkistrodon mokasen mokasen*) was brought to me at Kanawauke Lakes, Harriman State Park, New York. It had been killed nearby. The head had been severed so that the exact length could not be determined; the remains measured 30¾ inches. On examining the stomach contents 2 hawkmoth caterpillars were discovered. One was only slightly digested and the other probably had just been eaten as it was in perfect condition. As several captive copperheads were on hand and also a polyphemus caterpillar (*Telea polyphemus*), the latter was put into the cage with the snakes. The caterpillar disappeared, with a resulting bulge in an 18-inch copperhead, although the actual feeding was not observed. It seems quite evident that large caterpillars form a portion of the food of the copperhead, especially in late summer when

some of the large lepidopteran larvae (especially those of Sphingidae) are seeking favorable places to pupate in the ground.—John C. Orth, *American Museum of Natural History, New York City.*

FURTHER NOTES ON THE *PSEUDEMYS SCRIPTA* COMPLEX.—In a recent paper (1939) I described *gaigeae*, a subspecies of the *Pseudemys scripta* group. Stejneger (1938: 174) and Carr (1938: 122) have both discussed the specimen which I selected as the type of *gaigeae*.

The redescription of *cataspila* in Carr's paper is somewhat confusing since it is a composite involving the characteristics of *cataspila* and of *gaigeae*, and perhaps of intergrades between the two as well. The description of *Pseudemys s. gaigeae* thus necessitates the following corrections and changes in his data:

1. U.M.M.Z. 66472 is not *cataspila*, but is the type of *gaigeae*.
2. M.C.Z. 31974 is not *cataspila*, but is an intergrade between *gaigeae* and *troostii*.
3. The plastral pattern of *cataspila* is distinctly of the *ornata* type, and is not intermediate between the *troostii* and *ornata* types.
4. The temporal stripe (called "supratemporal" by Carr) is not broken in *cataspila* to form an elliptical spot bordered with black. This condition is typical of *gaigeae*.
5. Texas intergrades in this group are between *gaigeae* and *troostii*, and not between *cataspila* and *troostii*; and *cataspila* is not found in Texas.

References

Carr, A. J., Jr.
1938 Notes on the *Pseudemys scripta* complex. *Herpetologica*, 1: 131–135.
Hartweg, N.
1939 A new American *Pseudemys*. *Occ. Pap. Mus. Zool., Univ. Mich.*, 397: 1–4.
Stejneger, L.
1938 Restitution of the name *Ptychemys hoyi* Agassiz for a western river tortoise. *Proc. Biol. Soc. Wash.*, 51: 173–176.

Norman Hartweg, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

A NEW NAME FOR THE GENUS *EUDRYAS* FITZINGER 1843.—In a recent paper, Brongersma (Zoolog. Meded., XX, 1937: 4–5) calls attention to the fact that *Eudryas* Fitzinger (Sys. Rept., 1843: 26; type, *Coluber boddaerti* Sentzen, 1796) is preoccupied by the lepidopteran genus *Eudryas* Boisduval (Hist. Nat. Insectes, I, 1836: pl. 14 10B, fig. 9 and pg. 4 of explanation of plates; type, *Euthisanotia unio* Hübner 1825). As there is no confusion as to the identity of *Euthisanotia unio* and no other name is available, it is necessary to select a new name for the ophidian genus *Eudryas*. For this genus, as defined under the name *Eudryas* by me (Occ. Pap. Mus. Zool., Univ. Mich., 236, 1932; 4–5), I propose the name ***Dryadophis*** (Gr. Δρυάς, a wood nymph, and ʼόφις, a snake), thus retaining the original allusion of Fitzinger. The genotype, of course, remains *Coluber boddaerti*, Sentzen 1796.

Drs. Hobart M. Smith and E. R. Dunn have courteously withdrawn from publication names which they had proposed, and to them I wish to express my appreciation for allowing me to name this genus to which I have devoted a number of years of study. Mr. K. P. Schmidt suggested the new name, and Dr. Carl L. Hubbs aided in giving it the proper transliteration.—L. C. Stuart, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

Reviews and Comments

FISH PASSES IN CONNECTION WITH OBSTRUCTIONS IN SALMON RIVERS *being* The Buckland Lectures for 1937. By T. E. Pryce-Tannatt. Edward Arnold & Co., London, 1938: 1–108, 32 figs.

These lectures give a concise account of the English laws regarding obstructions in salmon rivers, a discussion of general considerations concerning obstructions to migrating salmon and trout, and they describe in detail three types of fish passes successfully used in England. The author is Inspector of Fisheries, Ministry of Agriculture and Fisheries, and evidently has had considerable first hand experience with fish passes and their problems.

Though English laws do not affect our problems in this country, they contain some provisions which we might well copy. For instance, the owner of a dam is obliged to install a fish pass if he is notified to do so by the Fishery Board, which must draw up the plans.

Under the heading "General Considerations Concerning Obstructions in Salmon River" is discussed the effect of barring salmon and trout from their spawning grounds and valuable observations and photographs are given to show how some types of dams may be impassable even though relatively low.

The three types of fish pass discussed are the "Diagonal Baulk," for dams having long, sloping downstream faces, or "backs"; the "Dished Channel," which is in principle a relatively narrow channel cut in the crest of a dam which is low and sloping but has insufficient depth of water flowing over it; and, lastly, the "Pool and Traverse," which is the series of pools and jumps commonly called a fish ladder on this side of the Atlantic. Recommended dimensions, gradients, and volumes of water are given, as well as formulae for determining the flow. Many types of notches for the walls in the "pool and traverse" type are discussed, and though many of them seem to be unnecessary refinements, they give valuable hints on methods of preventing excessive turbulence. The ladder or pass with underwater connections between the different levels is recommended for high dams, and the problems to be met in its design are discussed. The Tongland dam on the Kircudbrightshire Dee in Galloway has a successful ladder of this type, taking fish up 72 feet, but complete details on this dam are not given out of deference to the author of a forthcoming paper.

A little more information on the methods of getting fish up and down high dams would have been welcome, but this little book is nevertheless a valuable guide for anybody concerned with the innumerable small dams in this country, many of which block runs of salmon and trout as effectively as our Grand Coulee Dam on the Columbia River.—OSGOOD R. SMITH, *U. S. Bureau of Fisheries, Stanford University, California.*

COLOR CHANGES OF ANIMALS IN RELATION TO NERVOUS ACTIVITY. By G. H. Parker. University of Pennsylvania Press, Philadelphia, 1936: i–ix, 1–71, 40 figs. $1.50.—In this volume, Dr. Parker summarizes briefly the history of our knowledge of the mechanism producing color changes in animals, and reviews in detail the very significant contributions to the subject produced by himself and his students at Harvard University. It is of particular interest to ichthyologists that most of the experimental work done in Dr. Parker's studies and discussed in this book was on fishes, particularly the killifish, *Fundulus heteroclitus*, and the smooth dogfish, *Mustelus canis*. It is largely owing to these experiments, which should serve for all time as models of ingenious simplicity, that it is now fairly certain that neurohumors serve as active intermediaries in the chromatophoral system. The author suggests a possible rôle of these chemicals in other physiological processes, such as the excitation of smooth muscle and the control of the vertebrate heart muscle, a rôle yet to be investigated.—L. A. WALFORD, *Jordan Hall. Stanford University, California.*

ZACA VENTURE. By William Beebe. Harcourt Brace & Co., New York., 1938: i-xvi, 1-294, 23 figs. $3.00.—This is William Beebe's narrative of a two months' voyage on board Templeton Crocker's yacht, "Zaca," into the Gulf of California. That the voyage was productive in a scientific as well as literary way is attested by the fact that at least 16 papers on the collections made have appeared or are in preparation. These represent the work of 12 authors. "Zaca Venture," which seems to represent the bulk of Dr. Beebe's contribution to the work, is a travelogue, not very different from "Half Mile Down," "Nonsuch: Land of Water," "The Arcturus Adventure," etc. The book would be immeasurably fresher and less perfunctory if it were free of some of its excessively long quotations, which appear to be nothing more than padding; and it would be more palatable to biologists if readers were left with the impression that there are other scientists, also making interesting observations in the sea and contributing to our knowledge of marine life.—L. A. WALFORD, *Jordan Hall, Stanford University, California.*

A REVIEW OF FISHERY STATISTICS IN RELATION TO WHOLESALE-INDEX. By W. Nellemose. Conseil Permanent International Pour Exploration De La Mer. Rapports et Proces-Verbaux des Reunions, Vol. 48, 1936: pp. 1-72, 37 figs.—This paper gives a discussion of the best unit of value to which price statistics of fish and fishery products can be converted for accurate comparison among countries. Prior to the World War, any currency might have been used for this purpose, but after 1914, fluctuations in the value of monetary units have necessitated devising a standard. According to the author, "the wholesale index is the only index homogeneously calculated in practically all countries; the industries, imports and exports may differ from one country to another, but the index of each is calculated to give an expression of all round conditions.—Assuming that the wholesale-index fulfils this purpose, it seems natural to review value movements in an industry in relation to the movements of the index. The result obtained may not show any true picture of developments in that particular trade because other facts have to be considered, but it does produce a picture of developments in relation to conditions in general." Though the paper contains considerable information about the trend of values of fishery products in Europe, it is extremely burdened with graphs that do more to obscure the information than to make it clear.—VERNON BROCK, *Oregon Fish Commission, Portland, Oregon.*

PHYTOPLANKTON AND THE HERRING. Part I. 1921 to 1932. By R. E. Savage and A. C. Hardy. Fishery Investigations, Ministry of Agriculture and Fisheries, Series II. Vol. 14. No. 2, 1934. London, 1935: pp. 1-73, 42 figs. 3s 6d.

PHYTOPLANKTON AND THE HERRING. Part II. 1933 and 1934. By R. E. Savage and R. S. Wimpenny. Fishery Investigations, Ministry of Agriculture and Fisheries, Series II. Vol. 15. No. 1, 1936. London, 1936: pp. 1-88, 45 figs. 4s 6d.

PHYTOPLANKTON AND THE HERRING. Part III. Distribution of Phosphate in 1934-1936. By Michael Graham. Fishery Investigations, Ministry of Agriculture and Fisheries, Series II. Vol. 16, No. 3. His Majesty's Stationery Office, London, 1938: pp. 1-30, 15 figs. 2s 0d.

During the last decade or so, there have been cropping up in trade journals, administrative reports and technical papers hints of the success attending the efforts of fishery workers to learn the effect of plankton on the herring fishery of England. In these three papers is a welcome, connected report of the outcome of this ambitious project. In the southern part of the North Sea, abreast of the east coast of England, is an important herring fishery. The population of herrings has been sampled regularly for size and age composition, but the fluctuations in the success of the fishery could not always be connected with the occurrence of unusually good year classes. Something was preventing the population from being available to fishermen in proportion to its abundance. In Part I we learn that near the eastern edge of the fishing ground there is a site of enormous phytoplankton blooms, usually *Phaeocystis* or *Rhizosolenia*, sometimes *Biddulphia*, often reaching a climax in October and November, just at the time the east Anglian herring fishery usually is at its peak. This somehow reacts unfavorably on the herring shoals. During the ten years when the phytoplankton patches were surveyed, there were three seasons when these patches were either poorly developed or did not coincide with the time and locality of the fishery. In these years, the fishing was good. In six of the

seasons, the patches were well developed, either on the fishing grounds or in locations where they formed partial barriers to the shoals of herring migrating toward the fishing grounds. In these years, the fishing was poor or abnormal in time or location. In one year, economic conditions confused the biological picture. The harmful effect on the fishery of these phytoplankton blooms was thus directly and clearly demonstrated.

In Part II, we have a particularly detailed account of the various developments through 1933, when the greatest of all phytoplankton blooms was observed, and in 1934, when the phytoplankton development was negligible. Thanks to the intensive field work in these seasons, it was possible to follow the development of the phytoplankton population, its course of drift, its relation to the zooplankton and the herring, and some of its effects on the chemical constituents in the sea water itself. So thorough were these surveys that even the rate of multiplication could be estimated. Apparently the phytoplankton excluded both herring and later stages of zooplankton, but the increased oxygen content of the water in the patches evidently was favorable to the young stages of zooplankton, and the patches might therefore serve as particularly favorable nursery areas. The herring and the zooplankton tended to be at the leeward fringes of the phytoplankton patches, but not in any definite relation to each other. Is it possible that the patches leave in their wake particularly favorable conditions for pelagic animal organisms?

In Part III, an answer is sought to the question, "How is it that the *Rhizosolenia* patch is so commonly found hugging the southwest corner of the Dogger Bank?" It was found that this was regularly the site of maximal phosphate concentration. Though explaining the usual presence of the patches, this did not explain their occasional poor development or absence. From other considerations, it was concluded that development of a vast patch of this alga depends on persistence of favorable conditions, including sunshine, supply of nutrients, and sufficient hydrographic stability to keep the patch together during the many divisions over the considerable time required for its development. This complex of conditions is most likely to be favorable in weather associated with strong Atlantic influx.

This collection of papers perhaps marks the furthest advance in understanding of fishery fluctuations beyond the more conventional and still fundamental determinations of population units, fluctuations due to variable birth and death rates, and constitutes an example of the extent to which the mystery of fisherman's luck becomes solved as science extends the frontiers of knowledge. We await with interest the results of the obviously practical uses in prediction to which this information may be put. There also remains the still unanswered query as to what it is in the phytoplankton patches that excludes the herring and zooplankton from their midst.—O. E. SETTE, *Jordan Hall, Stanford University, California.*

POLITICAL ARITHMETIC, A Symposium of Population Studies. Edited by Lancelot Hogben. The Macmillan Company, New York, 1938: 1–531, several figs. $9.00. —Though this volume deals almost entirely with the sociological aspects of changes in human population, it should be of interest to those studying any population problems. The book is a collection of papers dealing with population changes in England and the sociological consequences. The last chapter by Allison Davis, "The Distribution of Blood Groups," is a penetrating discussion of the biological basis and principles of taxonomic classification. The author's views may best be expressed by his quotation, "A statistical concept of classification has as its objective basis in the fact that certain associations of attributes occur much more often than their random combination inferred from their separate frequencies would lead us to predict, and the practical significance of an ascending hierarchy of classificatory units resides in the fact that what is true of a comparatively small number of individual attributes is also true of larger groups of attributes." This at once suggests a method of distinguishing taxonomic units and a criterion for defining "races," "species," "genera," etc. For this contribution, the author may perhaps be forgiven the too-sweeping statement, "Anthropologists alone among taxonomists have applied statistical methods to the recognition of classificatory units."—REVIEW COMMITTEE.

LES TÉLÉOSTÉENS DYSSYMÉTRIQUES DU MOKATTAM INFÉRIEUR DE TOURAH. By Paul Chabanaud, V. 32. Mémoires de l'Institut d'Egypte. 1937: xi + 122, 19 figures, 4 plates.—This paper, published in a journal ordinarily given over to archeological research, stands alone. From the title it appears to be a description of fossil flatfishes of a province of Egypt. However, it is divided into two parts. The first, according to the preface, is for the purpose of showing clearly the relationship of the fossils to other fishes. This turns out to be a detailed but very concise description of the morphology, osteology, classification and relationships of the orders and families of the Heterosomata. The first chapter is concerned with the place of flatfish in the general classification of fishes. The next two chapters take up the Psettoidea and Pleuronectoidea. Chapter 4 is a synoptic table of classification, while chapter 5 gives the rachimeristic formula of almost all species of Achiridae and Soleidae. The second part of the work gives an exceptionally detailed description of three fossil species ending with a discussion of their affinities with other fishes. This paper summarizing such a vast amount of material and giving the opinions of one of the foremost authorities in the world, will doubtless long be a landmark to the students of the Heterosomata.—GORDON GUNTER, *Department of Zoology, University of Texas, Austin, Texas.*

FIELD BOOK OF FRESH-WATER FISHES OF NORTH AMERICA NORTH OF MEXICO. By Ray Schrenkeisen. Edited by J. T. Nichols and F. R. LaMonte. G. P. Putnam's Sons, New York, 1938: i–xii, 1–284, col. frontisp. and 97 figs. $3.50.—The lack of a popular manual for the ready and accurate identification of North American fresh-water fishes, and the pressing need for such a treatise, are rightly emphasized in the announcement of this book. The need still exists, for the manual under review proves inadequate in a number of ways. It is devoid of keys to families, genera or species. Only 94 species are illustrated, and the figures are generally outline sketches showing little character. Fewer than half of the known species are described, and these are only briefly and not always accurately characterized. The few words devoted to the other species included, in the paragraphs on "Related forms," will often fail to suffice for identification by an experienced ichthyologist, let alone a beginner. A few old species and a very considerable number of recently described or resurrected forms are wholly omitted.

Of particular annoyance is the consistent perpetuation of the almost innumerable erroneous or unwise features of Jordan, Evermann and Clark's *Check List* of 1930, the deficiencies of which have already been emphasized in COPEIA (1935, 4: 196–197). In fact, the present book, with few exceptions, merely repeats the check list, with items such as "Descriptions," "Habits" and "Distribution" added for the species which were selected (not always wisely) as important ones; leaving a greater number of forms to be barely mentioned, or treated too briefly for usefulness.

The uncritical division of the large genera *Notropis* and *Poecilichthys* is retained, although other recent generic separations, some better justified, are not accepted. Here and there through the book new nomenclatural treatments are indicated, apparently in a spirit of conservative systematic judgment rather than as a result of research.

It seems that the "Descriptions" were mostly abstracted from *The Fishes of North and Middle America* with the idea of presenting a few, easily observed, diagnostic features. This aim was realized, with varying degrees of success, for a large proportion of the species.

Under "Habits" are included brief statements, in general terms, on such natural history items as habitat, growth, food and breeding, as well as remarks on angling. These notes are often omitted or reduced to a couple of lines. For the game fishes and some other large, well-known species, the treatment is somewhat but not greatly expanded and is prepared with obvious experience and care.

The perpetuation of errors, through an undue trust in major treatises by great authorities, is more excusable than the almost complete neglect of recent contributions, not only the descriptions of new groups and forms and the discussions of proper nomenclature, but even critical group revisions. As an example, we refer to the omission of the interesting family Novumbridae, based on *Novumbra hubbsi* Schultz, 1929 (another forgotten family is Cichlidae, of which *Herichthys cyanoguttatus* of course should have

been included). Except for a few species which appeared in time for inclusion in the 1930 check list, none of the many species and subspecies of Coregonidae described by Koelz from 1921 to 1931 are included, and the treatment of this group is absolutely hopeless. Reviews of certain genera of lampreys, suckers, darters and other fishes are similarly neglected, although they appeared in time for consideration, and although they described, resurrected and redefined numerous species and called for an almost complete reclassification of the groups treated. Less comprehensive papers describing many new forms were similarly passed by, though surely available to the author and to the editors. Surely a main function of the manual should have been the bringing together of such scattered material.

It would be inexpedient to list the errors and omissions which mar this Field Book, for to do so, with reasons, would require all of the space in an issue of COPEIA. At least one correction, small or large, is needed on each of more than 200 pages. Particularly annoying is the use, once again, of the figure of *Poeciliopsis infans* to illustrate *Gambusia "patruelis"* (= *affinis*). Similarly, the error is repeated of using Forbes and Richardson's figure of *Macrhybopsis meeki* to portray the very different *Platygobio gracilis*.

In fairness to the author, Mr. Ray Schrenkeisen, who died before the manual was finished, it should be mentioned that an arrangement had been made by him to revise the systematic treatment with some ichthyologist actively engaged in a study of the rich and as yet poorly known fresh-water fish fauna of North America. It is unfortunate that this plan was not followed.—REVIEW COMMITTEE.

THE FISHES OF INDIANA. By Willis Stanley Blatchley. Nature Publishing Co., Indianapolis, Ind., 1938: 121 pp., 38 figs. $1.00.—This book suffers from many of the same faults as the one reviewed directly above. Its content and treatment are based primarily on Jordan's 1929 "Manual," and the author is blissfully unaware of the unfortunate shortcomings of that book, and of the fundamental revisional work that has been done on Mississippi Valley and Great Lakes Basin fishes in the last ten or more years. Blatchley's book therefore cannot be depended on for correct identifications of Indiana fishes. There is a key to families but none to genera or species, and one becomes lost trying to identify the minnows and darters. Only 37 of the 151 included forms are figured, but the drawings, fortunately, are mostly copied from those in the better standard treatises. Will casual workers on American fishes ever wake up to the fact that North American ichthyology is no longer *Jordan and Evermann* dressed up in the nomenclatural trappings of the 1929 *Manual* and the 1930 *Check-list*"?—REVIEW COMMITTEE.

MATHEMATICAL BIOPHYSICS. By Nicolas Rashevsky. University of Chicago Press, Chicago: xvi, 340 pp. $4.00.—Unfortunately some zoologists resent or are perturbed by the figures and formulae that in increasing numbers find their way into the pages of current biological literature. In an age when texts of statistics are appearing at least monthly and "Mathematics for the Millions" reaches the "best seller" class, such zoologists should do some thoughtful stock taking. A number of years ago Lord Kelvin said: "When you can measure what you are speaking about and express it in numbers you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind." You may object to this as too sweeping a condemnation of qualitative knowledge but it is clear that many biologists have seriously adopted a similar attitude and are applying mathematics to biology with varying degrees of insight and success.

One of the more ambitious attempts is "Mathematical Biophysics." In it, Rashevsky modestly undertakes an appallingly complex task. We may state it in his own words. "The importance of physics to biology is, at present, generally recognized. But, while physics in the twentieth century has developed into a rational mathematical science, biology as a younger science, must still, on the whole, be classified as a purely empirical, descriptive one. In this book we propose to lay the foundations for a mathematical biology, analogous in its methods to mathematical physics."

To bring mathematical biology to the same level is certainly not the work of any single individual. But somebody must start that task, must lay the first stone. And while the author certainly does not have any illusions as to the possibility of his living to the time when mathematical biology will become of equal standing with mathematical

physics, he does hope that at least some of the foundations laid down here are solid enough to enable others, who may be better qualified than the author, to build further."

The complexity and the brilliant results of mathematical physics are well known; the complexity of biology is apparent when we remember that it must embrace the complexity of both physics and chemistry as well as a complexity of relationships all its own. The book represents the revision and unification of views that Rashevsky has presented in journals over the last ten years. The experimental biologist will find in it provocative suggestions concerning the manner of interchange of materials between a cell and its surroundings and about the intimate nature of nervous processes, to cite only two of the topics treated. They differ from similar suggestions in the past in that they form part of a unified and generalized treatment of the larger problems of biology.

Whether or not you find your problem treated in this book, it should serve as a warning that mathematical analysis is a powerful tool without which you may be unable to do your own work justice or fully to appreciate the work of others as it appears in current biological journals.—F. W. WEYMOUTH, *Stanford University, California.*

DISCOVERY REPORTS. COAST FISHES. By John Roxbrough Norman. Part I, The South Atlantic: *Discovery Repts.*, 12, 1935: 1–58. Part II, The Patagonian Region: *Ibid.*, 16, 1937: 1–150, pls. 1–5. Part III, The Antarctic Zone: *Ibid.*, 18, 1938: 1–105, pl. 1. Cambridge, The University Press.—The recent publication of the third part of the report on the *Discovery* shore fishes concludes one of the most useful expeditionary reports in the history of marine exploration. Done in a competent and workmanlike manner, these papers are far more than mere lists of the fishes taken. Not only does Mr. Norman give us a complete revision of the Nototheniiformes, which make up the bulk of the Antarctic fish fauna, but also revisions or synopses of a number of other smaller groups or genera. Among these are: the genera *Psammobatis, Synagrops, Lepidion, Merluccius, Physiculus,* and *Muraenolepis;* Mediterranean and nearby Atlantic Scorpaenidae; Patagonian and Antarctic Zoarcidae; European and African *Squatina;* South African and Southern South American *Raja;* and South American *Clupea* and *Genypterus.* There are also discussions of the distribution of the Antarctic and Patagonian fishes and historical accounts of the explorations and literature. We must compliment Mr. Norman on a piece of work which fully upholds the solid reputation of the ichthyologists of the British Museum.—GEORGE S. MYERS, *Stanford University, California.*

NEW BOOKS RECEIVED

FIELD AND LABORATORY TECHNIC IN WILDLIFE MANAGEMENT. By Howard M. Wight. University of Michigan Press, Ann Arbor, Michigan, 1938: iii–viii, 1–107, 34 figs. $1.50.—"Presents accurate, rapid and concise methods of obtaining scientific information in the field of wild life management, with particular reference to game birds and game mammals."

PHILIPPINE FISH TALES. By Albert W. Herre. Oriental Commercial Company, Manila, 1935: i–xix, 1–302, several figs.—A series of essays about fish written for children living in the Philippine Islands. The style is clear without being condescending. Hence, the book is likely to prove interesting as well as informative to serious-minded young readers.

BIOLOGICAL SURVEY OF THE MERRIMACK WATERSHED. Survey Report No. 3, New Hampshire Fish and Game Department, Concord, New Hampshire, 1938: 1–238, several figs.

A NEW CATALOGUE OF THE FRESH-WATER FISHES OF PANAMA. By Samuel F. Hildebrand. Field Museum Press, Chicago, 1938; Zoological Series, 22 (4): 219–359, 13 figs. $1.50.

THE SPRAT AND THE SPRAT FISHERY OF ENGLAND. By J. Armitage Robertson, M.A. His Majesty's Stationery Office, London. Fishery Investigations, Series II, 16 (2), 1938: 3–103, 15 figs. 4s 6d.

A CONTRIBUTION TO THE LIFE HISTORIES OF ATLANTIC OCEAN FLYINGFISHES. By C. M. Breder, Jr. Bulletin of The Bingham Oceanographic Collection, Yale University, New Haven, Conn., 1938, Art. 5: 1–126, 47 figs.

EDITORIAL NOTES AND NEWS

News Notes

THE WESTERN DIVISION of the ASIH will meet with the Pacific Division of the American Association for the Advancement of Science, June 26 to July 1, 1939, at Stanford University, California. More than twenty organizations will participate, and an unusually large attendance is expected, for an added attraction this year will be the outstanding exhibits at the nearby San Francisco World's Fair.

In addition to regular sessions, it is planned to have a symposium of invitational papers on "The Effect of Dams and Other Engineering Structures on Migratory Fishes" which should prove of great interest to all scientists.

April 20th is the deadline for titles of papers, as the program must be made up far in advance. Authors should send titles, accompanied by a 200-word abstract, a careful estimate of the time required for delivery, and a request for any special equipment (stereopticon lantern, stating size of slides, cinema projector, stating width of film, etc.) to the Chairman of the Local Committee, GEORGE S. MYERS, before that date. The other members of the Local Committee are ALBERT W. HERRE, PAUL R. NEEDHAM, OSCAR E. SETTE, MARGARET STOREY, and LIONEL A. WALFORD.

PROFESSOR B. S. ILYIN, well known to ichthyologists through his studies on the Gobiidae, is now in charge of the ichthyological laboratories, 26 in number, of the All-Union Institute of Sea Fisheries and Oceanography, Moscow. Nevertheless, he is planning to devote a portion of his time to further studies on the Gobiidae at the Zoological Institute of the U.S.S.R. Academy of Sciences. The Institute is planning to carry out a large-scale tagging program with the Caspian herrings. Other interesting work includes studies by divers of both the behavior of various fish and the actual operation of fishing gear, such as trawl nets.

The FOURTH AMERICAN WILDLIFE CONFERENCE was held in Detroit, February 13–15, and was followed by the meeting of the WILDLIFE FEDERATION. The technical sessions, arranged by the American Wildlife Society, included two on Fish Management, and there were panel discussions on interstate cooperation in the regulation of migratory fishes, on pollution, and on mosquito control. The Trustees of the American Wildlife Institute voted to continue financial support for the encouragement of research in fish management. The Wildlife Society expressed a desire to strengthen its membership in the field of fish management. Fishery workers wishing to join the Society or to make inquiries may contact DR. CARL L. HUBBS, Vice-President, at the University of Michigan, Ann Arbor.

DR. THOMAS BARBOUR left early in February for Florida to attend a meeting at the Fairchild Arboretum, of which he is a Trustee, and then went on to Cuba for his annual inspection of the Harvard Laboratory at Soledad.

The fourth edition of the *Check List of North American Amphibians and Reptiles* is in press. Herpetologists wishing interleaved books may order unbound copies from the Harvard Press.

On October 6 and 7, a national fisheries convention and exposition was held in Boston, Mass., which was attended by many representatives of the fishery industry from all sections of this country and Canada. Discussions at the meetings and round-table groups centered around phases of production, handling, and merchandising of fishery products. Considerable profitable discussion also was given over to methods for promoting consumer acceptance of sea foods through cookery schools, radio broadcasts, publicity, newspaper and magazine advertising, speakers' bureaus, and the like.

Recent appointments to the staff of the Pacific Biological Station to fill vacancies resulting from various resignations are as follows: PROFESSOR FERRIS NEAVE, who is to study the salmon and trout production on the Cowichan River systems; DR. R. V. BOUGHTON, who is to carry on ocean fishery investigations; MR. D. QUAYLE, who is to investigate the clam fishery; MR. J. L. MCHUGH, who is to be assistant in the pilchard

and herring investigations; and MR. W. M. CAMERON, who is to be assistant in the salmon investigations.

On December 17, the *N. B. Scofield,* new research boat of the California State Fisheries Laboratory, was launched at San Diego. So far as we know, this is the first state-owned vessel to be used exclusively for fishery research on the high seas. The vessel is a motor ship, 100 feet long, 24-foot beam, has a speed of 10 knots and a cruising radius of 5,000 miles. A temperature control system is installed to maintain even temperatures in staterooms and brine tanks under any conditions. The tanks are equipped with remote control temperature gauges, permitting extensive experiments in the transportation of various species of fish from banks to canneries. The vessel has accommodations for a crew of 14, with additional staterooms for four scientists. Deck arrangements and equipment render it capable of operating virtually all kinds of commercial fishing gear. In addition, there is a small winch on the after boat deck for operating special hydrographic and plankton nets. Electrical equipment includes a complete telephone service, radio telephone, commercial wireless and radio direction finder as well as sonic finder.

A request has been received from RALPH DE SOLA, Zoological Editor, Federal Writer's Project, 110 King St., New York City, for photographic records of our native wild-life, feathered, furred, finned or scaled. Pictures of reptiles, amphibians and fishes are especially desired at this time for inclusion in the "Natural History of the United States." The project has no money to pay for prints, but due credit will be given to contributing photographers, amateur or professional.

Ichthyologists throughout the world will be interested to learn that DR. LEV SEMENOVICH BERG of Leningrad, Honorary Foreign Member of our Society, has recently completed forty years work upon the fishes of his native country. One of his earliest papers, entitled "Ueber Theilung und Bildung des Parablastes bei *Esox lucius,*" was published early in 1899, and from that time onwards a veritable stream of valuable contributions, mainly of a taxonomic nature, has flowed from his pen, and well over one hundred papers bearing his name have appeared in scientific journals throughout the world. Always a patient and careful worker, Dr. Berg has come to be regarded as the foremost authority upon the freshwater fishes of the U.S.S.R., and is a recognized authority upon problems concerning the geographical distribution of fishes. His imposing work on the freshwater fishes of the U.S.S.R. and neighboring countries, a third edition of which appeared in 1932–33, will long remain a standard work, invaluable to all students of Palæarctic fishes. Dr. Berg, who was born in 1876, is still actively engaged in his work, and his many friends and co-workers will wish him many more years of fruitful labour on his beloved fishes.

Recent Deaths

MR. EARL E. HOOVER, biologist of the New Hampshire State Department of Fish and Game, died at Concord on January 8, after an illness of several weeks. Hoover, an active member of our society and a contributor to COPEIA, was perhaps the most promising of the younger workers in the field of fresh-water fish management. His third annual survey report, only recently published, was a tribute to his dynamic energy and thorough competence. He made contributions to herpetology as well as ichthyology and fisheries research, and was engaged in a brilliant research dealing with the effect of altered periods of daylight on the time of reproduction in trout. An investigation of dwarfing in trout, from the systematic as well as fisheries viewpoint, was well under way and was to have been utilized for a doctorate dissertation at the University of Michigan.

Hoover was born at Somerset, Pennsylvania, December 5, 1911. His undergraduate studies were carried on at Lebanon Valley College, and graduate work was done at Johns Hopkins University, where he served as instructor in 1934–35. Before assuming his position in New Hampshire in 1936, he worked one year as field zoologist in the National Park Service. Despite this tragically short career, Earl Hoover made many friends, and a very real impression in several fields of scientific endeavor. His loss will be keenly felt, but his accomplishments will live on.

CARLOS CLYDE GOFF, Assistant Entomologist of the Florida Experiment Station, died on January 13. He was born on October 2, 1905, at Charleston, Illinois. He specialized

in plant and animal ecology at the Eastern Illinois Teacher's College and at the University of Illinois. From 1927 to 1930 he was Assistant Entomologist with the Illinois State Natural History Survey. In 1930 he joined the staff of the Florida Experiment Station, on which he continued until his death, except for a year's leave spent at the University of Michigan completing the preliminary requirements for the Ph.D. degree.

Mr. Goff's wide interests were shown by his contributions in the fields of mammalogy, herpetology, entomology and animal ecology. He was a particularly gifted field investigator. His earlier studies in Florida were on the vertebrate pests of the state crops. More recently he had been occupied by studies of the life-history and habits of *Geomys* and of the commensurals inhabiting *Geomys* and *Gopherus* burrows, within which he had found practically an unexplored source of insect life. It is hoped that his work may be prepared for publication by his Florida colleagues.

The Florida Experiment Station has lost an associate whose broad interests and enthusiasm contributed much to the work of the organization, and promised more for the future. Mr. Goff's quiet friendliness, his kindly wit and his unfailing good humor endeared him to all who knew him, and he will be keenly missed by his many friends.

Dr. Henry Van Peters Wilson, formerly Professor of Zoology at the University of North Carolina, and widely known in ichthyology for his excellent treatise on the embryology of the black sea bass, died on January 4th in his seventy-sixth year.

The recent deaths of three distinguished ichthyologists and fishery workers, William Converse Kendall, James Playfair McMurrich, and George Charles Embody, will receive further notice in the next number of Copeia.

Editorial Comments

A NEW policy for the ichthyological reviews is being initiated with this issue; henceforth, works of particular importance, or those on whose merits authors are likely to disagree, will be submitted to a committee, whose opinions will be summarized and reported by the ichthyological editor.

We welcome the announcement that Biological Abstracts is being issued sectionally, as well as in its complete form this year for the first time. The lower cost of the sections, as compared with the whole journal, will place the *Abstracts* within the reach of individuals, and hence remove the journal from the class of purely library reference work. The following subject grouping into five parts has been adopted:

I. *Abstracts of General Biology* to include General Biology, Biography-History, Bibliography, Evolution, Cytology, Genetics, Biometry, and Ecology; price $4.

II. *Abstracts of Experimental Animal Biology* to include Animal Physiology, Nutrition, Pharmacology, Pathology, Anatomy, Embryology, and Animal Production; $9.

III. *Abstracts of Microbiology and Parasitology* to include Immunology, Bacteriology,Viruses, Parasitology, Protozoology, and Helminthology; $5.

IV. *Abstracts of Plant Sciences* to include Phytopathology, Plant Physiology, Plant Anatomy, Paleobotany, Systematic Botany, Agronomy, Horticulture, Forestry, Pharmacology, and Pharmaceutical Botany; $6.

V. *Abstracts of Animal Sciences* to include Paleozoology, Parasitology, Protozoology, and Helminthology, Systematic Zoology, and Economic Entomology; $6.

The subscription price for the complete volume 13 for 1939 will be $25 to individual subscribers and institutions alike.

Financial aid in the publication of this issue of Copeia has been received from Major Chapman Grant.

Corrections

THROUGH an oversight of mine, the name of A. C. Taft, Chief of the Bureau of Fish Conservation of California, was omitted from the reference *Observations on the Spawning of Steelhead Trout,* by *Needham, Paul R., and Taft, A. C., 1934, Trans. Amer. Fisheries Soc., vol. 64, pp. 332–338, figs. 1 and 2,* cited in my article "The Breeding Habits of Salmon and Trout," Smith. Rept. for 1937 (1938): 365–376.—Leonard P. Schultz, *United States National Museum, Washington, D. C.*

Through an error in the bindery, the second and fourth pages of the Table of Contents of Copeia 4, 1938, were transposed.—Ann Arbor Press.

COPEIA IS THE JOURNAL OF THE AMERICAN SOCIETY OF ICHTHYOLOGISTS AND HERPETOLOGISTS

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